# Usability, Accessibility and User Experience Evaluation of ADA Blocks by HCI Experts

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***Abstract. Introduction****: Educational technologies have been important in supporting the teaching and learning process.* ***Objective:*** *In this context, this paper presents a study evaluating the usability, accessibility, and user experience of the ADA Blocks virtual assistent that was designed to recommend block programming tools for teachers.* ***Methodology or Steps****: Ten HCI experts participated in this study, seeking to identify improvements and promote more efficient and satisfactory interactions for this assistant.* ***Results:*** *Problems such as design inconsistencies, lack of responsiveness on mobile devices, navigation difficulties, and accessibility barriers, among others, were identified. These findings enable improvements to ensure that ADA Blocks can be effective, inclusive, and generate a good experience for its users.*
***Keywords*** *Usability, Accessibility, User Experience, ADA Blocks*

## 1. Introduction

The adoption of educational technologies has become increasingly important in supporting teaching and learning in different contexts [Hartono et al. 2018]. An example of these educational technologies is block programming environments, are composed of distinct characteristics and colors that indicate their functions, such as commands and values, facilitates the formation of the program structure. The commands and values are organized in interlocking blocks, making the programming process less complex and allowing the inclusion of different audiences, such as teachers and students in basic education, so that they can experience programming [de Souza Rios et al. 2019]. Block programming has been used as a visually friendly methodology with the intention of working on computational thinking, complex problem-solving, technology design and programming, among others, through concepts from the area of Computing. In this context, researchers and professionals are constantly exploring new approaches to teach programming to students [Guzdial 2004]. For these tools to be effective and that they meet Usability (US), Accessibility (AC) and User eXperience (UX) criteria, in order to ensure that they are intuitive, inclusive and aligned with the needs of their users. In this scenario, evaluation of educational technologies and tools by experts in the area of Human-Computer Interaction (HCI) shows promise in identifying areas for improvement and promoting more efficient and satisfactory interaction [Medina-Flores e Morales-Gamboa 2015].

With the aim of encouraging and supporting teachers in choosing block program tools to assist teaching and learning processes in the development of skills such as computational thinking, logical reasoning and programming, the ADA Blocks assistant was developed. The assistant was created due to the wide diversity of block programming tools available, since, when teaching block programming, teachers may face challenges due to a lack of familiarity with these tools. Furthermore, they may feel insecure about choosing the tool that best suits the context and specific needs of their classes. The ADA Blocks assistant has a set of questions that address aspects such as support material, language, subject, among other relevant factors. These questions aim to facilitate the suggestion of the block programming tools that are most appropriate to the context of each subject for the teacher.

Therefore, we performed a study to evaluate the ADA Blocks virtual assistant, a tool designed to recommend block programming tools, aimed at teachers. The analysis was conducted by ten HCI experts, to answer the question: “What are the main US, AC and UX problems identified by HCI experts in the ADA Blocks virtual assistant?". It is important to evaluate ADA Blocks to ensure that the assistant meets the US, AC and UX guidelines, ensuring its effectiveness, good experience and inclusion for users. Furthermore, for this study, adhered to Nielsen’s recommendation of involving a minimum of three experts to evaluate the US of a system [Nielsen 2003]. By engaging ten HCI experts, the research not only met but exceeded this recommendation, ensuring a robust and comprehensive assessment. Evaluation of US can be done through tasks or questionnaires with predefined criteria, helping to identify whether the system meets the requirements or presents flaws. This approach ensures robust and reliable analysis.

This paper contributes to the field of HCI by critically and comprehensively evaluating the virtual assistant ADA Blocks, in alignment with three Grand Challenges of GranDIHC-BR (2025–2035) [Pereira et al. 2024]. First, it addresses Challenge 1 (New Theoretical and Methodological Approaches) by proposing an integrated methodological model (US/AC/UX) for evaluating educational technologies. It also contributes to Challenge 4 (Socio-Cultural Impacts) by focusing on the pedagogical impact of ADA Blocks for elementary school teachers, proposing corrections that aim to increase its effectiveness and inclusion in the Brazilian educational context. In addition, it aligns with Challenge 2 (Ethics and Responsibility) by identifying and correcting accessibility barriers (such as subtitles and contrast), reinforcing human rights and digital inclusion. The study demonstrates how assessment not only identifies technical problems, but also responds to national priorities in HCI, promoting ethical, inclusive and socially relevant educational solutions.

This paper is organized into 7 sections. Section 2 presents related work on educational technology evaluation. Section 3 presents the ADA Blocks virtual assistant. Section 4 addresses the methodology used in the study. Section 5 presents the results and discussions of the quantitative and qualitative data, respectively. Section 6 presents the limitations of the study. Finally, Section 7 presents final considerations and future work.

## 2. Related works

The studies analyze specific challenges faced by groups with diverse needs when interacting with virtual visitors, namely: (1) usability in domestic contexts; (2) motor and speech disabilities; and (3) visual impairment and educational applications for the blind. The following papers are organized thematically according to their approach in AC, US and UX.

Barbosa (2019) investigated the AC of virtual assistants with a focus on people with visual impairments. The study analyzes how blind people interact with virtual assistants, such as Siri and Google Assistant, on smartphones, pointing out that AC is still treated as a secondary priority in the development of digital products, even in view of the growing use of these technologies by people with visual impairments. The research aimed to propose recommendations for the design of more inclusive interfaces, combining a literature review, adaptation of AC and US heuristics, and two experiments: one with heuristic evaluation conducted by 10 specialists (5 to evaluate Siri and 5 for Google Assistant) and another with tests involving 6 blind users. The results revealed significant challenges, such as the absence of labels on buttons, failures in feedback during interaction, and incompatibility between assistant interfaces and screen readers. The research reinforces the need to integrate AC from the initial stages of design, adopting principles of universality and conducting tests with real users. The paper concludes that AC should not be understood as a technical obstacle, but as an opportunity to create more humane and inclusive solutions that can benefit all users. Furthermore, it highlights the transformative role of the designer, who must consider human diversity in their creative process, promoting digital experiences that respect the needs of different audiences [BARBOSA 2019].

Ballati et al. (2018) investigated the effectiveness of virtual assistants (Google Assistant, Siri and Cortana) in interpreting voice commands from people with dysarthria caused by Amyotrophic Lateral Sclerosis (ALS), highlighting the importance of these technologies as AC tools for individuals with motor limitations. The study involved eight patients with moderate dysarthria (classified as “detectable speech” or “intelligible with repetition” by the ALS FRS-r scale), treated at the Molinette Hospital in Turin. Thirty-four sentences in Italian were recorded and played on smartphones to simulate real-world usage conditions. The analysis focused on two criteria: Question Comprehension (QC), assessed by the Word Error Rate (WER) and the semantic/literal similarity between the command and the transcription, and Consistency in Answer (CiA), which categorized the responses as coherent, incoherent or generic. The results revealed that no assistant was completely effective, but Google Assistant stood out as the most promising, providing more accurate transcriptions and responses for moderate dysarthria. The study reinforces the need to improve speech recognition systems, incorporating a diversity of vocal patterns to ensure effective AC, especially in cases of speech disorders. The research highlights that, although virtual assistants have potential, there are still critical gaps to be overcome to adequately meet the needs of users with dysarthria, highlighting the urgency of more inclusive and adaptive technological solutions [Ballati et al. 2018].

Barbosa et al. (2022) investigated user interaction with the Amazon Alexa virtual assistant, analyzing the UX at different points in time, based on a survey involving 25 participants (15 beginners with no previous experience and 10 regular users with at least three months of regular use). Using mixed methods (quantitative and qualitative), combined with semiotic and communicability analyses, structural problems were identified in the interface, such as unintuitive icons (e.g., the“+"symbol to add devices), excessive technical language, and lack of clear feedback, categorized by the labels “Where is it?"and “What now?"without communicability. These flaws explain the high resistance rate in basic tasks among beginners, who, although fascinated by the novelty, face US barriers that limit the effective use of the system. The usual users, over time, partially adapted, developing a more specialized use and valuing the practicality of home automation, although they still suffered from simultaneous problems, such as imprecise voice recognition and persistent complexity of the interface. As recommendations, the researchers suggest simplifying critical flows (e.g.: adding devices), eliminating technical jargon in favor of accessible language, improving contextual feedback systems and improving the accuracy of voice commands — changes that would reduce the initial learning curve and make the technology more inclusive, balancing innovation and functionality in users' daily lives [Barbosa et al. 2022].

Cunha et al. (2024) investigated the use of Intelligent Virtual Assistants (IAVs) in the education of blind people through a systematic literature review. The analyzed works revealed advances, challenges, and impacts of these technologies in the educational context. The results highlighted that the most widely used IVAs include both tools already integrated into operating systems (such as Siri and Google Assistant) and customized solutions. Among these, the most prominent are "Adrisya Sahayak", an assistant in Bangla that facilitates access to computers and home devices; "Smart Cap", a device with IoT and computer vision for text and image recognition; and "Nyx", an Android application that converts physical and digital texts into audiobooks through voice commands. These technologies have been shown to promote autonomy by reducing dependence on human assistance, allowing blind users to access information independently and participate in practical activities, such as in science laboratories, through voice instructions (e.g., VLA system). However, the study identified challenges such as the lack of standardization in evaluation methodologies that make it difficult to compare results between different IAVs. In addition, the scarcity of blind participants in research and the absence of longitudinal studies limit the understanding of long-term impacts. To overcome these gaps, the researchers recommend the creation of standardized frameworks that integrate AC, US, and pedagogical impact criteria. They also emphasize the need for collaborative research involving end users in the design process (co-design), ensuring that solutions meet real and diverse needs. However, its potential will only be fully realized with investments in culturally adaptive innovations, robust long-term studies, and multidisciplinary collaborations that prioritize human diversity. This work reinforces the importance of aligning technology and pedagogy to build a future where accessible education is a universal reality [Cunha et al. 2024].

The ADA Blocks study by HCI experts, described in this paper, stands out for its specialized focus and integrated methodology, differentiating itself from previous research that addresses generic virtual assistants or specific solutions for specific disabilities. While studies such as those by Barbosa (2019) and Ballati et al. (2018) focus on AC for people with visual impairments or dysarthria, and Cunha et al. (2024) analyze tools for blind students, ADA Blocks is designed to assist high school teachers, regardless of your needs, in the selection of block programming tools, integrating pedagogical criteria, technical support and emerging technologies (e.g., robotics). Its expert evaluation combined US, AC and UX. This multidimensional approach overcomes the fragmentation observed in previous studies, which often treat AC as an isolated component. US, AC and UX are interrelated aspects and ensuring that educational tools are effective, engaging and accessible to all users. Furthermore, continuous evaluation and improvement of these tools are essential to adapt them to constantly changing educational and technological demands. By involving ten HCI experts (exceeding Nielsen's minimum recommendation), the study identified complex issues, such as design inconsistencies and lack of responsiveness on mobile devices, that conventional end-user testing could overlook. In addition, the study also proposed evidence-based improvements, such as an intelligent search system and automatic data saving, features missing from generic tools. By evaluating the ADA Blocks virtual assistant, incorporating evaluator feedback and making adjustments based on rigorous evaluations, it is possible to optimize the ADA Blocks, making it more efficient and aligned with the real needs of the educational process. Thus, this study not only validates the existing tool, but also advances the debate on how technology can be an ally of human diversity and educational equity.

## 3. ADA Blocks Virtual Assistant

The Brazilian Computer Society (2018) emphasizes the need to include computer science education in Basic Education, aiming to educate citizens with essential knowledge and skills to deal with the challenges of contemporary society. In this scenario, block programming can be a means to develop skills such as logical and computational thinking, essential in the context of the 21st Century. In this way, the teacher can assume the role of facilitator, offering personalized support for complex issues and encouraging student autonomy [Hartono et al. 2018]. However, a common challenge in this process is the lack of knowledge about the tools available to support block program teaching, which generates insecurity among teachers in choosing the most appropriate platform for their pedagogical context. To mitigate this gap, support and encourage high school teachers of any discipline in the selection of these tools, the ADA Blocks virtual assistant was developed. The assistant asks questions about support materials, language, subject matter, and other relevant criteria, generating personalized recommendations for block programming tools that align with the teacher's pedagogical context. This dynamic approach allows suggestions to be tailored to each teacher's specific needs, ensuring more assertive and contextualized choices.

The creation of the ADA Blocks virtual assistant followed a process structured in eight interconnected steps, combining empirical research, theoretical analysis and iterative development. The steps for creating the ADA Blocks virtual assistant were: (1) an opinion survey conducted with 255 high school teachers to understand the challenges faced in the use of Digital Technologies Information and Communication (DTICs) in teaching and learning processes and which resources were used during the remote period [Perin et al. 2021b]; (2) a Systematic Mapping Study (SMS) that analyzed studies published in databases such as ACM Digital Library, IEEE Xplore, SpringerLink and Scopus, focusing on identifying DTICs that support the teaching of programming and computational thinking through block programming [Perin et al. 2023]; (3) an opinion survey with high school teachers that specifically investigated the use of block programming tools as support material for teaching and learning processes [Perin et al. 2022b]; (4) a benchmark of block programming tools, in which 58 existing tools were cataloged, analyzing characteristics such as compatibility with platforms (web, mobile, desktop), applicable disciplines (Mathematics, Physics, Arts) and support for emerging technologies (e.g.: Arduino) [Perin et al. 2021a]; (5) the implementation of the ADA Blocks virtual assistant; (6) a feasibility study of the assistant carried out with high school teachers [Perin et al. 2022a]; (7) evolution of the assistant based on the results obtained in the feasibility study; and finally (8) a study on AC, US and UX with experts in HCI where the results are presented and discussed in this paper.

The ADA Blocks virtual assistant is a technology developed to recommend block programming tools to high school teachers. The ADA Blocks was built using HTML, CSS and JavaScript technologies for the Front-End. In the Back-End, PHP was used for server logic, MariaDB as the database management system (through the phpMyAdmin) and Apache2 for hosting, to ensure scalability. In addition, the informal “Code and Fix"approach was adopted for the development of the virtual assistant. In this strategy, during the implementation, there was no clear separation between the coding and testing phases — both occurred simultaneously, with the tests being performed as the code was written. This practice allowed for rapid adjustments to specific functionalities, however, without a structured planning of iterations or systematic documentation [Misra et al. 2012]. The pedagogical basis of ADA Blocks is based on Seymour Papert’s constructionism, which values active learning [Papert e Harel 1991]. This approach guided the design of the tool, to encourage teachers to explore block programming with their students as a tool for expression and problem-solving. The overview of the ADA Blocks virtual assistant web page is represented in Figure 1.

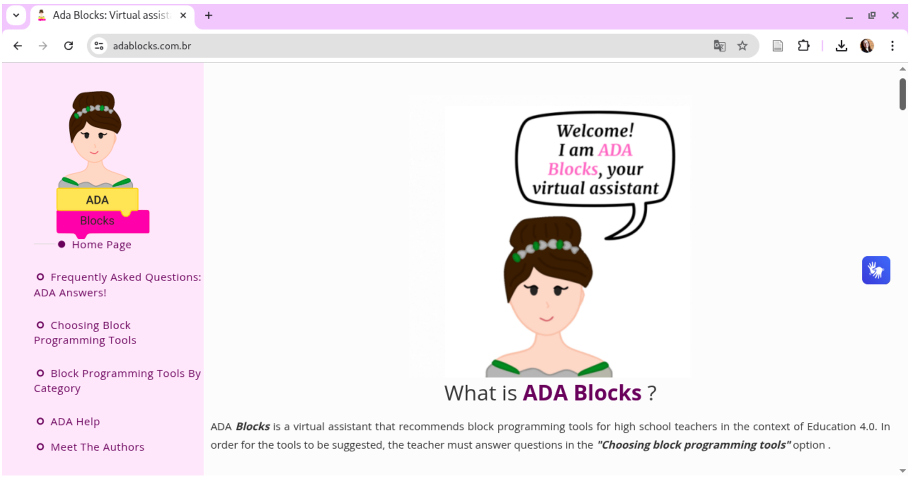


**Figura 1. ADA Blocks virtual assistant webpage overview.**

The ADA Blocks virtual assistant web page is in its second version, improved after a feasibility study conducted with high school teachers [Perin et al. 2022b] and is organized into six sections in the menu, each with a specific purpose. The **home page** was developed to introduce the assistant to teachers, highlighting its main objective: to assist in choosing block programming tools adapted to the pedagogical context. The menu item, entitled **Frequently asked questions: ADA Blocks answers!**, was created to clarify recurring questions among teachers. In this section, there are structured questions and answers, such as: 1) “What is block programming and why is it important?"; 2) “What are block programming environments?"; 3) “Why use block programming?"; 4) “How to integrate block programming in the classroom?". These FAQs aim not only to resolve technical doubts, but also to provide pedagogical support for teachers, encouraging the adoption of the use of block programming tools.

When interacting with the menu item **Choosing Block Programming Tools**, the virtual assistant presents a dynamic questionnaire to recommend block programming tools. The process is divided into two main steps: (1st) data entry and (2nd) analysis and recommendation of block programming tools. In the 1st step, the teacher answers an adaptive questionnaire consisting of ten questions, each with at least two answer options. The navigation logic is conditional: the next question is defined based on the previous answer, ensuring a personalized flow. Interaction with the ADA Blocks questionnaire follows an adaptive flow, where each teacher's answer determines the next question, ensuring personalization. For example, when answering the question "In which subject do you intend to use the tool?", the teacher can choose between options such as Math, Science or Arts. Based on this choice, the next question will be conditionally directed. If you select "Mathematics", the assistant will ask "Do you want to use any support material?", with options of Yes or No. If the teacher answers "Yes", they will be asked about the "priority type of material", such as video lessons, PDF material, among others. If you choose "PDF material", the sequence may include additional questions, such as "Do you want to use a block programming tool in conjunction with another technology (e.g. robotics)?", keeping the focus on the specific needs of the pedagogical context. This mechanism eliminates questions that do not meet the teacher's needs and prioritizes precise recommendations, reducing interaction time and increasing the assertiveness of the suggestions. The recommendation questionnaire has ten questions and is presented in Table1.

**Tabela 1. Block Programming Tool Recommendation Quiz Questions**

| id | Question |
|---|---|
| 1 | In which discipline do you want to use the block programming tool? |
| 2 | Do you want to use any support material? |
| 3 | Who will use the support material? |
| 4 | What type of support material do you want to use? |
| 5 | Which platform do you want to use the block programming tool? |
| 6 | Which mobile operating system do you want to install the tool on? |
| 7 | Which desktop operating system do you want to install the tool on? |
| 8 | Do you want to use a block programming tool in conjunction with another technology? For example, Robotics, among others. |
| 9 | Which technology do you want to work with in conjunction with block programming? |
| 10 | In which language of the block programming tool do you want to use it? |

In the flowchart presented in Figure 2 it can be seen that the initial question refers to the subject in which the teacher wishes to use the block programming tool. For this question, there are twelve possible answers (A) that cover the subjects of High School, according to the National Common Curricular Base (Base Nacional Comum Curricular - BNCC, 2018). For each subject, a set of tools is recommended. The 58 tools (T) that are available on the ADA Blocks *web* page are: [T01AgentsCubes; [T02] Alice ; [T03] MIT AppInventor; [T04] Art:bit; [T05] Beetle Blocks; [T06] BlocklyDuino; [T07] Blockuino; [T08] Blocky; [T09] BloclyGames; [T10] BrickLayer; [T11] ChoiCo; [T12] Code Kano; [T13] Code.oSrg; [T14] CodeMao Turtle; [T15] Csnap; [T16] DroneBlocks; [T17] DuinoBlock; [T18] Engage; [T19] Gameblox; [T20] Hackeduca Conecta; [T21] Judge; [T22] Kitten; [T23] KittenBlock; [T24] Kodetu; [T25] Kodular; [T26] Lego; [T27] Lightbot; [T28] LookingGlass; [T29] MBlock; [T30] Micro:bit; [T31] Mind+; [T32] MiniBloq's; [T33] MusicBlocks; [T34] ModKit; [T35] NetsBlox; [T36] OzoBlocky; [T37] PencilCode; [T38] Pilas Blocks; [T39] Poredu; [T40] Progkids; [T41] Rita;

[T42] Roblockly; [T43] Scratch; [T44] S4A; [T45] Sketchware; [T46] Snap!; [T47] Snap4Arduino; [T47] StartLogo; [T49] Tello Edu; [T50] Thunkable; [T51] Tickle; [T52] Tinkecard; [T53] Tynker; [T54] Ubbu [T55] Vittascience; [T56] Stencyl; [T57] logicBlocks; and [T58] Catrobat.

Figure 3 presents two examples of flowcharts that the teacher can follow, using the subject Q1 (Question) of Mathematics as an example. Figure 3a presents two possible paths that the teacher can follow when informing that he wants to use support material (Q2). In path 1, the teacher informed that he wants to use support material for himself and his students (Q3) and of the forum type (Q4), the platform (Q5) chosen is web, and that he does not want (Q8) to use emerging technologies. Up to this path, it can be seen that of the seventeen initial tools that could be suggested, when applying the filter, three tools remained to be suggested by ADA Blocks . When the teacher informs that he wants the tool to have a language (Q10) in Portuguese, a filter is applied again, with two tools suggested at the end (Judge and Scratch). In path 2, the teacher reported that he wants to use support material for himself and his students (Q3) and of the forum type (Q4), the platform (Q5) chosen is web, and that he wants (Q8) to use emerging technology Robotics (Q9) and that the tool be in the language (Q10) Portuguese. It can be seen that of the seventeen initial tools that could be suggested, when applying the filter, only one tool remained to be suggested by ADA Blocks (Scratch).

In Figure 3b, two possible paths are presented that the teacher can follow when informing that he does not want to use support material (Q2). In path 1, the teacher reported that the platform (Q5) chosen is web, that he does not want (Q8) to use emerging technologies, and that the tool has the language (Q10) in Portuguese. It can be seen that of the seventeen possible tools that could be suggested initially, after applying the filter, eight tools remained to be suggested by ADA Blocks (MIT AppInventor, Blocky, Judge, NetsBlox, Roblockly, Scratch, Snap!, Ubbu). In path 2, the platform (Q5) chosen is web, the teacher informs that he wants (Q8) to use emerging technology Robotics (Q9) and that the tool is in the language (Q10) Portuguese. It can be seen that of the seventeen initial tools that could be suggested, when applying the filter, four tools remained to be suggested by ADA Blocks (Blocky, NetsBlox, Roblockly, Scratch). The 2nd stage takes place after the questionnaire is completed, the responses are processed and a list of personalized block programming tools is recommended, based on the teacher's responses. An example of a recommended tool can be seen in Figure 4.

The **Tools by Category** menu item offers an organized repository of block programming tools, classified by characteristics such as platform, language, emerging technologies and disciplines. Each main category is divided into specific subcategories, allowing for refined navigation. For example, when selecting the Platforms category, the teacher can choose between options such as web, mobile or desktop. If the teacher chooses web, the assistant lists all the tools compatible with browsers, detailing characteristics such as access links, pedagogical support, among others. In addition, the view all option allows you to explore the complete repository without filters, ideal for teachers who want to freely compare tools or seek inspiration.

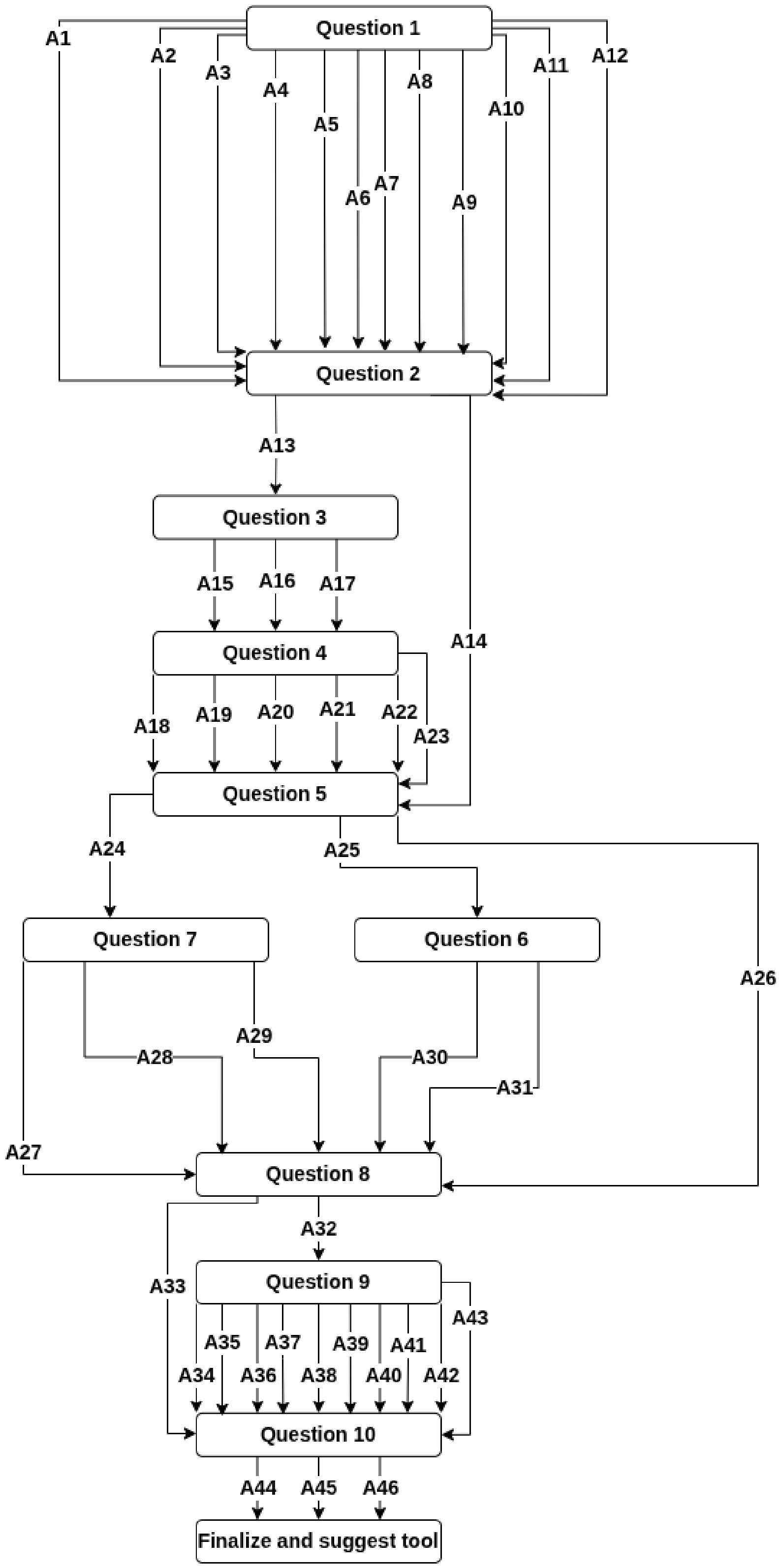


**Figura 2. Recommendation Questionnaire Flow Overview.**

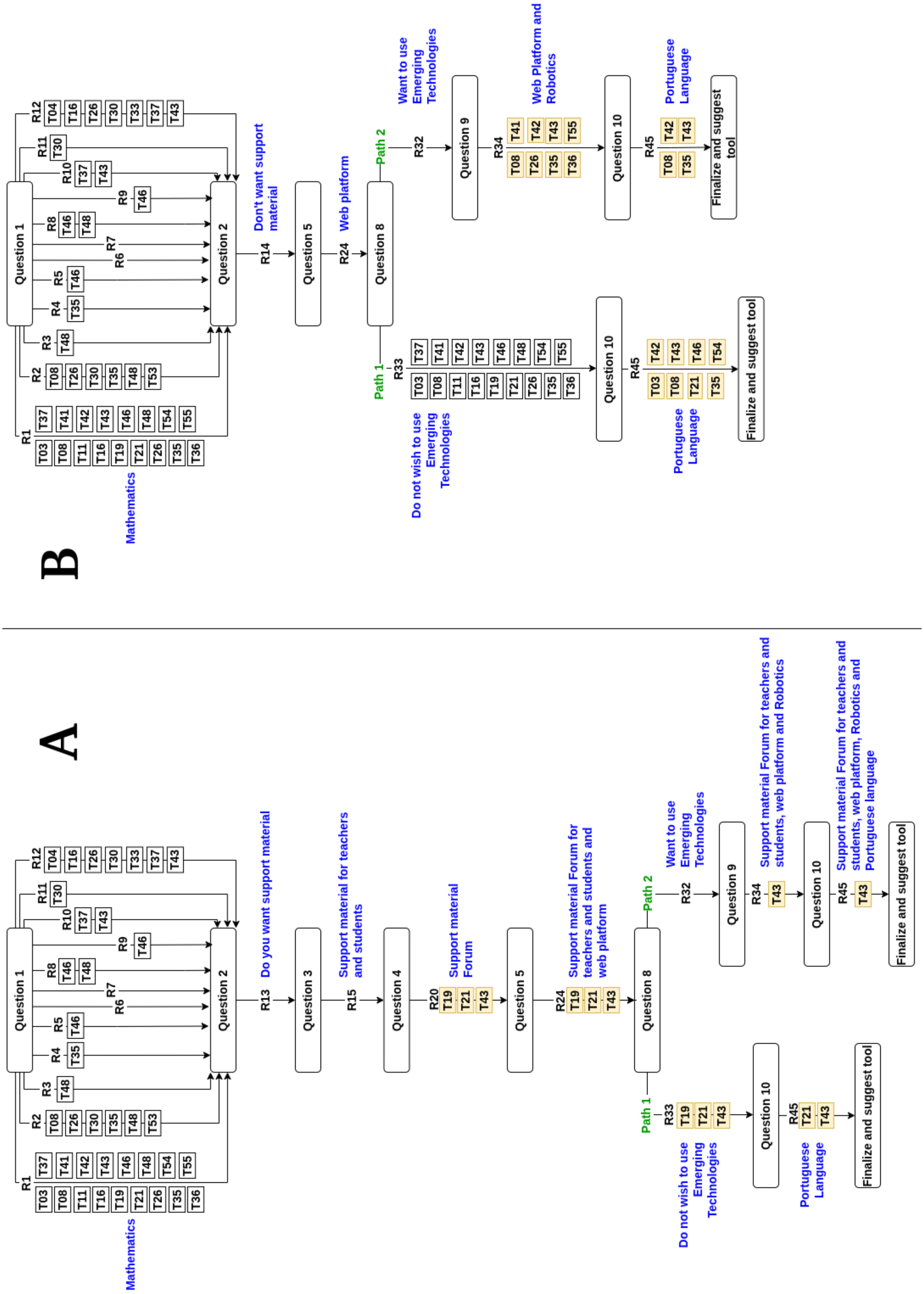


**Figura 3. Fluxo do questionário de recomendação com ferramentas a serem sugeridas.**

Alice

| Tool Name: **Alice** | |
|---|---|
| Discipline: | No disciplines were identified in which this block programming tool could be used. |
| Emerging Technology: | This block programming tool can be used in conjunction with emerging technology(ies) such as: 3D Digital Games. |
| Teacher Support Material: | This tool has a tutorial for the teacher. |
| Student Support Material: | No student support material was found related to this block programming tool. |
| Operating System: | This tool can be used on Gnu/Linux, Windows and macOS operating systems. |
| Platform: | This tool works on Desktop platforms. |
| Language: | This tool is available in English language(s). |
| Login: | It is not necessary to register (login) to use the tool. |
| Address: | https://www.alice.org/ |

**Figura 4. Example of suggested tools at the end of the questionnaire and their information.**

The **ADA Help** menu item, the virtual assistant offers an interactive user guide, composed of explanatory videos that demonstrate step by step how to use the platform. These visual resources are designed to clarify common questions, such as navigating the questionnaire and interpreting the recommendations. Finally, when accessing the item **Meet the authors**, teachers will find a section dedicated to the creators of ADA Blocks, with information about their background and a direct channel for suggestions for improvement. This transparency reinforces the commitment to continuous improvement and collaboration with the educational community.

## 4. Experts Evaluation

The experts evaluation was conducted with the purpose of creating a body of knowledge about the ADA Blocks virtual assistant from the perspective of HCI experts. Expert evaluation is considered a professional and objective method, especially when the evaluators have knowledge in US, AC, and/or UX, in addition to clearly understanding the objectives of the investigation [Tullis e Albert 2008, Nielsen 2003, Medina-Flores e Morales-Gamboa 2015]. These experts must be familiar with the system under evaluation and understand the implications of its use in the specific context in which it will be applied. The knowledge mentioned above allows for a critical and well-founded analysis, identifying possible problems and contributing to improving the quality of the system [Medina-Flores e Morales-Gamboa 2015].

In the case of the ADA Blocks virtual assistant, the evaluation by HCI experts is particularly relevant, since the assistant did not undergo an evaluation conducted by experts during its ideation. In addition, it is crucial to verify that the assistant meets the established guidelines and recommendations for US, AC and UX, to ensure that it is effective and inclusive for its users. For this study, we followed the Nielsen recommendation of having a minimum of three experts to evaluate the US of a system's design and implementation. This evaluation can be carried out using a list of tasks or a questionnaire with predefined measurement criteria, which allows identifying whether the system meets the established requirements or whether it presents inconsistencies, errors or flaws in its design. This approach ensures a robust and reliable analysis of the system [Nielsen 2003].

This study was approved by the Research Ethics Committee (REC)[1], and carried out in three stages: (1) Planning; (2) Execution; and (3) Analysis. In the Planning stage (1), the target audience was defined as HCI experts. Subsequently, study participants were invited to participate by e-mail. The steps defined for the study were: (1) Presentation of the ICF and the objective of the study, (2) Presentation of the functionalities and the recommendation questionnaire of the ADA Blocks virtual assistant and and your web page, and (3) Presentation of the data collection methods. To present the study, it was decided to use the ADA Blocks website itself [2]. Furthermore, the data collection questionnaires were defined, namely: characterization questionnaire and data collection spreadsheet. The characterization questionnaire contained six multiple-choice questions, with the objective of knowing the profile of the experts, and whether they had prior knowledge about the term block programming. To collect the problems identified by the participant, an electronic spreadsheet was provided to the experts.

The Execution stage (2) took place in July/2024. In the first contact via email, a summary of the study was presented, and if the experts wished to participate voluntarily, an online meeting was scheduled according to their availability. During the meetings, the researcher in charge briefly introduced the virtual assistant website. The researcher showed how to navigate the web page, the function and purpose of each menu item, and also how to explore the block programming tool recommendation questionnaire. Interactions with experts were conducted individually, ensuring that each participant had a dedicated space to ask questions and provide guidance according to their concerns. This approach made it possible to avoid group influences. Regarding the evaluation method, HCI experts were free to select evaluation techniques, using methods aligned with their specialties or previous experience in US, AC or UX. This flexibility ensured that the analyses reflected diverse and in-depth perspectives, enriching the identification of problems and opportunities for improvement. Subsequently, the ICF was presented, and any doubts were clarified. After that, the experts were instructed to choose one or more US, UX, and/or AC assessment methods of their interest to identify problems in ADA Blocks. They were also instructed to use the assistant ADA Blocks at the time they found most convenient to assess the US, UX, and/or AC of ADA Blocks, answer the characterization questionnaire and the data collection spreadsheet, validated and used by [Menezes 2022]. The data collection spreadsheet was structured with the following fields to be filled out: 1) Evaluator: Name or identification of the responsible evaluator; 2) Date: Date on which the assessment was carried out; 3) Problem ID: Unique identification for each problem detected; 4) Link to file or image: Reference to a file or image that illustrates the problem, when applicable; 5) Problem description: Details of the problem identified; and 6) Evaluator's comments and observations: Space for additional observations or relevant considerations from the evaluator, if necessary. One week was given to answer

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[2]https://adablocks.com.br/

the questionnaire.

## 5. Results and Discussion

Ten HCI experts participated in this study. The results obtained were organized into two parts: (1) Characterization data of the HCI experts; and (2) Qualitative data from the data collection spreadsheet.

### 5.1. Characterization of Participants

Regarding the gender of the experts (question 1), 50% (N = 5) are male and 50% (N = 5) are female. Regarding age (question 2), 70% (N = 7) of the specialists are between 20 and 30 years old, 20% (N = 2) between 31 and 40 years old, and 10% (N = 1) between 41 and 50 years old. Regarding qualifications (question 3), 90% (N = 9) of the participants have a master's degree, while 10% (N = 1) have a specialization. Regarding the area of activity (question 4), 38.5% (N = 5) work in academia as a researcher, 30.8% (N = 4) work in academia as a professor, 23.1% (N = 3) work in the private sector, and 7.7% (N = 1) work in the public sector.

Regarding the length of experience in the HCI area (question 5), 30% (N = 3) have worked for 6 years, 30% (N = 2) have worked for 5 years, 20% (N = 2) have worked for 7 years, 20% (N = 2) have worked for 9 years, and 10% (N = 1) have worked for 3 months. Regarding the expert knowing the term "block programming" before knowing the tool ADA Blocks (question 6), 90% (N = 9) responded that they knew the term, while 10% (N = 1) responded that they did not know it.

### 5.2. Qualitative analysis and discussions

In this section, we present the qualitative data collected through a structured electronic spreadsheet made available to participants during the study. The spreadsheet allowed for a detailed record of the perceptions and difficulties reported by participants during their interaction with the ADA Blocks virtual assistant. To organize and interpret the responses, the identified problems were categorized into three main axes: 1) US Problems: Related to efficiency, effectiveness, and satisfaction in performing specific tasks (e.g., difficulties in locating functions) [International Organization for Standardization 2019, Mirmig et al. 2015]; UX Problems: Associated with emotional aspects, subjective perceptions, and engagement (e.g., frustration with the interface) [International Organization for Standardization 2019]; and 3) AC Problems: Referring to barriers that limit equitable access for users with different needs (e.g., lack of adequate visual contrasts, incompatibility with screen readers) [Albert e Tullis 2022]. The organization of the data is presented in the technical report[3].

After, the problems identified in each category were quantified, allowing the frequency and distribution of the most recurrent problems to be mapped. Overall, the evaluations resulted in 80 different problems, of which 63 of the US, 11 of the UX, and 06 of the AC. All the problems, including duplicate problems, are presented in Tables 1, 2, and 3 of the technical report.

[3]https://doi.org/10.6084/m9.figshare.28429922.v1

### 5.3. US Problems

Example of US problems are presented in Table 2 and are discussed in the following. All identified US problems are presented in the technical report[4].

**Tabela 2. US Problems Reported by Participants.**

| Participant | Reported Problem |
|---|---|
| P7 | I was unable to access the Judge tool |
| P4 | At times the design becomes inconsistent |
| P9 | Lack of responsiveness / The system does not work as it should on mobile devices. |
| P5 | **The application must offer features that reduce user effort.** For example, the autocomplete function, use of voice commands and voice search. Imagine that I have already found the platform I want to use, but I only remember its name. A search option would make it easier for the user to not have to answer the questionnaire again. In other words, they would just type the name of the platform in this option and ADA Blocks would present it. |
| P3 | When the question-asking functionality starts, you can't click on the options in the left side menu, otherwise the questions menu will close and restart. I don't know if this should happen. Perhaps, to avoid the error, the menu should remain open, in case the user missclicks. |

The difficulties when trying to access the Judge, reported by P1 be related to different factors, such as technical failures on the website, difficulties with authentication, access restrictions, or even changes to the link to access the tool. When accessing the link to the tool available on ADA Blocks, a change was observed on the access page, which may have contributed to the participants' difficulty. Considering that Judge is now called Beecrowd, this name change may have caused confusion. To mitigate this problem, it would be advisable to implement an appropriate redirection and clear notices about the change. In addition, it is essential to update the name of the tool on the ADA Blocks virtual assistant as well, ensuring greater consistency and avoiding confusion when clicking on the access link.

P4 reported that at times, the design of ADA Blocks is inconsistent, and noticed that some visual and functional elements vary without a clear pattern, which may compromise the UX. Among the main observations, the lack of uniformity in the layout of icons, colors used and interactions stood out, generating confusion and difficulties in navigating ADA Blocks. To improve this inconsistency, the intention is to adopt a well-defined style guide that establishes clear standards for colors, typography, icons and spacing. In addition, using components suitable for ADA Blocks's responsiveness can ensure that the design remains harmonious across all screens. The intention is also to conduct continuous testing with users to identify problems and adjust the design to improve the fluidity of navigation and the overall experience. Ensuring that each element of the system follows a logic and with harmonious screens can avoid these failures and provide a more intuitive and pleasant experience.

P9 identified a problem of lack of responsiveness, noting that ADA Blocks does not work as expected on mobile devices. Participants reported that, when accessing the platform on smartphones, several elements of the interface do not adjust correctly to the screen, compromising the UX. Some of the issues highlighted include overlapping

[4]https://doi.org/10.6084/m9.figshare.28429922.v1

text and poor navigation experience. To address these issues, a responsive design that dynamically adjusts to the device's screen size will be adopted. Techniques such as media queries and flexible grids will be implemented to ensure that interface elements adapt appropriately regardless of the device. In addition, navigation will be optimized for touch screens, ensuring that buttons and links are easy to access and use. Finally, tests will be conducted on several mobile devices to identify specific issues and ensure a fluid and efficient experience, both on desktops and mobile devices.

Regarding the effort reduction mentioned by P5, the participant suggests features such as autocomplete, voice commands, and voice search. P5 emphasizes the need for a search engine for block programming tools that allows users to quickly find a platform without having to redo the recommendation questionnaire. This suggestion by P5 demonstrates concern for efficiency, US, and information retention, since one of the main problems identified is the cognitive effort generated by the repetition of tasks, since the user does not want to fill out a form again. Thus, features such as smart search and automatic suggestions would help minimize these challenges, making access faster and more intuitive. One way to solve this problem could be by implementing an efficient search system that allows users to quickly find the desired block programming tool by typing only part of its name. The search can be optimized with autocomplete and algorithms that tolerate typing errors. In addition, commands and voice search would be useful alternatives to facilitate access, especially for those who have difficulty typing or prefer faster interactions. Another solution would be to temporarily store the questionnaire responses. A history of recent accesses could also be displayed to provide an even more fluid experience. Finally, an intuitive interface with personalized suggestions would help guide the user without requiring additional effort. These improvements would not only optimize the UX, but also increase user satisfaction and retention at ADA Blocks.

About the loss of information when navigating through the side menus, P3's comment highlights a critical problem in the application's US. When starting to fill out the questions and interact with other elements of the interface, the user expects their data to be preserved, but when clicking on a side menu, all the information entered is lost without any warning or recovery mechanism. This problem compromises the UX, and can lead to frustration and abandonment of the process. In addition, this problem shows that ADA Blocks does not have an adequate data persistence system or navigation warnings. One way to solve this problem could be by implementing an automatic saving system by temporarily storing data in the browser (localStorage or sessionStorage) or on the server itself. Both forms of automatic saving ensure that if the user leaves the page and returns, the information entered is still available. Additionally, another solution could be to add a confirmation notice when trying to leave the page or access another menu, alerting the user that the information may be lost and offering the option to save before continuing.

With these improvements, ADA Blocks would ensure greater security and confidence for users, reducing the risk of frustration and increasing the efficiency of the user. Implementing a saving system, alerts and smarter navigation are essential steps to offering a more intuitive and satisfactory experience.

### 5.4. UX Problems

Regarding the US problems, 11 problems were identified. Some of these problems are presented in Table 3 and discussed below. The remaining problems identified are presented in the technical report[5].

**Tabela 3. UX Problems Reported by Participants.**

| Participant | Reported Problem |
|---|---|
| P4 | When filling out the questions, the user is left in agony not knowing how many questions are left to finish |
| P7 | Depending on the user's answers, the system skips some questions, and makes them out of order: 1, 2, 7, 10 |
| P2 | The "Frequently Asked Questions"section doesn't really seem to be a "Frequently Asked Questions"section, but a Rationale section. Frequently Asked Questions usually present questions related to the website, how to use the tool, how to use AdaBlocks in my class, in my planning, others. |
| P4 | The sequence of information activities presented to the user does not make the tool inviting, in the sense of, why were "frequently asked questions"presented before I could use the main feature of the tool? Furthermore, as a teacher who seeks to integrate block programming, I already know what it is about, so this information ends up getting in the way in this place. Be direct, show the main feature of the tool right away. |

P4 concern about the user's distress when filling out a questionnaire without knowing how many questions are left to complete is a fundamental aspect of UX. A lack of clarity about the duration of the process can lead to feelings of frustration, impatience, and abandonment of the block programming tool recommendation questionnaire before it is completed. When the user does not have a clear idea of their progress, it can increase feelings of fatigue and demotivation. One way to minimize this problem is to implement a progress indicator, such as a progress bar or a numerical count that shows the percentage completed or the number of questions remaining. This feature helps to establish clear expectations and allows the user to visualize their progress throughout the process of answering the block programming tool recommendation questionnaire, reducing uncertainty and anxiety. In addition, this functionality can be complemented with a user-friendly design, such as subtle animations or encouraging messages during completion, making the experience more engaging and enjoyable. Another way to solve this problem is to allow the user to review and edit their answers before finishing the questionnaire. This flexibility can contribute to a less stressful experience, as the user feels more in control of the process. By combining these solutions, completing the questionnaire becomes more predictable, controlled, and comfortable, which reduces anxiety and increases the use rate of the ADA Blocks block programming tool recommendation questionnaire.

Concerning the issue of the problem with the sequence of the system's questions, reported by P7, where, as the user answers, some questions are skipped, resulting in an irregular order, such as 1, 2, 7, 10. This behavior can generate confusion, as the user may feel that they have missed information or that the system is working inconsistently. In addition, the discontinuity in numbering can impact the UX, making the interaction

[5]https://doi.org/10.6084/m9.figshare.28429922.v1

less fluid and possibly increasing frustration. This problem is related to the logic used to display questionnaire questions, where the next question presented is based on the previous answers. One way to solve this problem is to implement a dynamic navigation system that restructures the numbering as the questions are displayed, ensuring a logical and continuous sequence. By applying this solution, the ADA Blocks virtual assistant's block programming tool recommendation questionnaire can provide a more intuitive and organized experience, reducing confusion and improving the user's perception of the questionnaire's fluidity.

About the problem mentioned by P2, who points out that the "Frequently Asked Questions"section of the website is not fulfilling its main function, the authors of this study agree that there is a disconnect between the content presented and the users' expectations. Instead of providing practical answers about the use of the platform, the section is being used to present theoretical foundations, which can generate confusion and frustration among users who seek quick solutions to their questions. One way to solve this issue is by restructuring the section, starting with a change in the nomenclature. The term "Frequently Asked Questions"could be replaced by "About the Platform"or "Theoretical Foundation", aimed at users who want to understand the concepts and theoretical bases behind the ADA Blocks virtual assistant. In parallel, a new "Frequently Asked Questions" section could be created, focusing on practical issues related to the use of ADA Blocks and its application in real-world contexts, such as in the classroom or in pedagogical planning. This structure would allow users to quickly find the information they need, aligning the experience with their expectations. In addition, the inclusion of practical examples, tutorials or step-by-step guides could enrich the content, making it more accessible and useful. These changes would not only improve the UX, but would also ensure that each section of the website fulfills its specific purpose by clearly separating theoretical foundations from practical guidelines.

Finally, regarding P4, he highlighted a problem with the organization of information within ADA Blocks, suggesting that the UX is neither fluid nor inviting. Furthermore, P4 questions the logic of presenting the "Frequently Asked Questions" section before the tool's main feature, the block programming tool recommendation questionnaire, arguing that this hinders more experienced users, such as teachers who are already familiar with the concept of block programming. The central suggestion is to be more direct and provide immediate access to the main feature, avoiding unnecessary steps. The authors of this study agree with the participant's point of view, indicating that the feedback reveals a common challenge in interface design: balancing AC for new users without hindering those who already have experience. One way to solve this problem could be by reorganizing the interface to ensure that the main feature is available right on the home screen.

### 5.5. AC Problems

Regarding AC problems, 06 problems were identified. Some of these problems are presented in Table 4 and discussed below. The remaining problems identified are presented in the technical report[6].

The lack of options to adjust screen contrast, highlighted by P1, represents a

[6]https://doi.org/10.6084/m9.figshare.28429922.v1

**Tabela 4. AC Problems Reported by Participants.**

| Participant | Reported Problem |
|---|---|
| P1 | The website does not allow changes to the screen contrast, which makes access difficult for people with low vision. |
| P3 | There are no subtitles on the videos on the website. |
| P5 | Avoid screens with too much content in a vertical orientation. Visually impaired people and people with low vision rely heavily on memory. The more information on the same screen, the more difficult and tiring interaction becomes for these users, in addition to leaving them lost. |
| P5 | The application must suggest activating AC, privacy and location settings on mobile devices to the user when accessing it for the first time. |

significant barrier for users with low vision, compromising the AC and US of the site. Visually impaired users often have difficulty seeing text and interface elements when there is insufficient contrast between the background and the information presented. This limitation not only impairs the UX, but also goes against widely recognized AC guidelines, such as the WCAG [(W3C) 2018] recommendations, which emphasize the importance of adapting colors and contrast to promote digital inclusion. One way to address this issue is to implement a high contrast mode, which allows the user to switch to a version of ADA Blocks with more vibrant colors and greater differentiation between visual elements. This functionality can include options to adjust the color scheme, brightness, and saturation to meet the specific needs of each individual. Additionally, ensuring compatibility with AC extensions and tools, such as screen readers and automatic contrast adjustments in the operating system, can further expand access possibilities. In this way, by adopting an accessible design, theADA Blocks virtual assistant not only promotes the inclusion of users with low vision, but also improves the overall experience, making the interface more readable and functional for everyone. These improvements reflect a commitment to diversity and AC, aligning with web development best practices and ensuring that ADA Blocks is usable by a wider and more diverse audience.

The lack of captions in the videos, highlighted by P3, represents a significant barrier to AC and inclusion for diverse users. Although the videos feature speech bubbles that simulate ADA Blocks's dialogue with the user, people with hearing impairments and difficulties understanding audio may face obstacles in fully accessing the content. The authors of this study agree that the lack of captions directly impacts the UX, limiting ADA Blocks's AC and reducing its reach. To address this issue, it is necessary to implement captions in the videos, allowing users to turn them on or off according to their needs. This feature would provide a more personalized and inclusive experience, ensuring that content is accessible to everyone, regardless of their hearing condition or the environment they are in. Additionally, the inclusion of synchronized and high-quality captions can improve the comprehension of content, benefiting not only users with hearing impairments, but also those who prefer to consume information in silence.

P5 highlights the need to avoid screens with excessive vertical content, since users with visual impairments or low vision rely on memory to navigate and understand interfaces. For users who use screen readers, reading long content sequentially can be challenging, making interaction more time-consuming and potentially frustrating. To address this issue, it is necessary to adopt good accessible design practices, such as organizing content into smaller, well-structured sections with a clear hierarchy that facilitates navigation. The use of fixed menus or quick navigation buttons can allow users to access different parts of the content without having to scroll excessively. Additionally, implementing accessible shortcuts for screen readers, which allow direct navigation to specific sections, can significantly improve the UX. By implementing these improvements, ADA Blocks's interface can become more accessible and intuitive, regardless of the visual limitations of its users.

Finally, P5 also highlights that suggesting that AC, privacy, and location settings be activated when accessing an app for the first time is a practice that seeks to improve the UX by promoting inclusion, security, and personalization. An effective way to address this issue is through context-based suggestion, in which the app identifies specific moments to recommend activating certain settings. For example, when detecting difficulties in interaction, the app can suggest AC options, or when requesting data permissions, it can guide the user through privacy settings. In this way, control remains in the hands of the user, who can decide which settings to activate and at what time, ensuring a more personalized and respectful experience.

## 6. Ethical Care

This study involved 10 HCI experts and followed national ethical guidelines (CNS Resolution No. 466/2012 and supplementary documents). It was approved by the REC/FUPR under CAAE: 78743624.0.0000.0102. Participants were recruited via email and signed a REC informed consent form detailing objectives, methods, risks (minimal, time-limited), and benefits. Participation was voluntary and unpaid. Identity was protected by coding (P1 to P10) in analyses, without disclosing names. No images of participants were used (the figures refer exclusively to the ADA Blocks interface). Interactions were individual to avoid group influence and ensure privacy. The collected data were stored with restricted access, and participants were free to withdraw at any time.

## 7. Conclusions and Future Work

The evaluation of the ADA Blocks virtual assistant by HCI experts presented relevant issues related to US, AC and UX. The results demonstrated that, although the tool offers a useful mechanism for recommending block programming platforms, there are significant challenges that can compromise the fluidity of interaction and user adoption.

To answer the research question, the main problems identified by HCI experts included inconsistencies in the design, lack of responsiveness on mobile devices and difficulties in navigation. The analysis also pointed out that the absence of an efficient search system and the lack of data persistence in the questionnaire increase the user's cognitive effort, which can lead to frustration when using ADA Blocks. With regard to AC, the lack of options for adjusting contrast and the absence of subtitles in the videos hinder the inclusion of users with special needs. In addition, aspects of UX were impacted by issues such as the non-intuitive order of the questions in the questionnaire for recommending block programming tools and the presentation of the topic ”frequently asked questions"before accessing the recommendation questionnaire.

The study proposes a series of improvements to optimize the virtual assistant. In this way, it intends to implement an intelligent search system, redesign the interface to make it more intuitive, align the assistant with WCAG AC standards, and improve responsiveness for mobile devices. It also intends to implement a mechanism for automatically saving questionnaire responses, avoiding data loss if the user navigates to other sections of the assistant. These findings not only expose the problems identified in the virtual assistant, but also offer a structured guide for corrections, combining academic rigor with practical applicability.

This study has some limitations that should be considered when interpreting the results. The first of these is the detailed data on the profile and expertise of the participants were not collected, such as their areas of specialization within HCI (US, AC, UX), their level of knowledge and practical experience, and which assessment technique was used to evaluate the ADA Blocks. This lack of information makes it difficult to assess the representativeness and depth of the experts' contributions, which may result in biased or incomplete conclusions. These limitations suggest the need for caution when generalizing the conclusions and highlight the importance of future studies with larger samples and more robust criteria for selecting experts.

This study represents a contribution in the field of HCI by conducting an integrated and critical evaluation, analyzing dimensions of US, AC and UX. The study not only identifies practical challenges in educational technologies, but also proposes evidence-based solutions, reinforcing the relevance of specialized evaluations in the software development cycle. Its results contribute to the development of a more inclusive assistant aligned with the real needs of teachers, highlighting the importance of balancing functionality, inclusion, user satisfaction and experience, ensuring that educational technologies are not only efficient but also equitable.

The study validates the importance of evaluation by HCI experts during software development, following Nielsen's recommendation to involve at least three evaluators. This practice has proven to be crucial for identifying critical flaws that directly impact the adoption of technologies, such as interface inconsistencies and navigation barriers. The results reinforce the need to integrate technical feedback from the initial stages, ensuring that tools meet quality standards and the expectations of end users.

In the context of digital inclusion, the research advances by proposing concrete adaptations for users with specific needs, such as people with low vision or hearing impairments. By implementing solutions such as video subtitles and high contrast options, the work promotes equity in access to education, highlighting the role of HCI in building truly inclusive digital environments. This approach not only solves specific problems, but also inspires a culture of design centered on human diversity, encouraging practices that consider the plurality of users' needs and experiences.

For future work, it will be essential to validate these improvements through testing with high school teachers, in order to evaluate the effectiveness of the adaptations and collect new feedback for the refinement of the assistent.

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