Feasibility Study of the ADA Blocks Virtual Assistant by HCI Experts

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Abstract: Block programming emerged as an alternative to textual programming education due to its complexity. In this context, the need to support teachers in selecting this type of tool was recognized. For this purpose, a virtual assistant named ADA Blocks was created and used. Therefore, this paper presents a feasibility study to evaluate the acceptance of ADA Blocks. Ten experts in Human-Computer Interaction (HCI) assessed this assistant. The study's results revealed that most experts agreed on the ease of use and usefulness of the virtual assistant ADA Blocks, as well as concerns regarding its development in terms of accessibility. Some limitations were also identified, such as the inability to revisit a question when necessary.

1 INTRODUCTION

The challenges of the 21st Century, such as adapting to emerging technological resources and processes, demand an education more aligned with the needs of the contemporary world. In this context, collaborative environments can be an alternative to the traditional classroom model, fostering interaction, experimentation, and connection among students. These environments enable student agency and the development of essential 21st-century competencies and skills. This approach can facilitate the understanding and critical and creative use of technologies. Among the important competencies and skills to develop in students are: technological proficiency, leadership, collaboration, effective communication, emotional intelligence, autonomy, and teamwork (Führ and Haubenthal, 2019).

According to Hartono et al. (2018), it is essential to adopt an appropriate methodology so that students understand the materials used in the teaching and learning processes. In this context, planning and preparing teachers to apply new pedagogical methodologies become essential to promote student protagonism (Santos et al., 2019). Hartono et al. (2018) highlight that the role of the teacher includes: (1) encouraging collaborative learning through experiences and social interactions; (2) fostering autonomy, decision-making, and critical thinking, allowing the student to choose what, when, how, where, and why to learn; (3) offer practical learning opportunities, supported by technology; and (4) provide learning experiences beyond the confines of the classroom.

Therefore, one way to prepare students for the challenges of the 21st Century and develop their skills and competencies can be through programming. However, using textual programming languages can make the learning process more difficult due to the complexity of the syntax of most languages (Burnett and McIntyre, 1995; Souza and França, 2013), which can make it difficult for students to develop Information Systems (IS), in addition to developing skills necessary for the challenges of the contemporary world. An alternative to minimizing this difficulty can be through the use of block programming, which can make learning more attractive by providing a visual and intuitive experience (Rios et al., 2019). Furthermore, block programming allows an interdisciplinary approach, promoting the development of concepts related to Logic and Computational Thinking in schools.

However, when teaching block programming, teachers may face difficulties due to a lack of familiarity with the various tools available. In addition to the possibility of feeling insecure when choosing the tool that best adapts to the context and specific needs of their classes. To support and encourage high school teachers in choosing block programming tools for use in the classroom, the ADA Blocks virtual assistant (Perin et al., 2022) was developed.

High School was chosen to help teachers at this

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level of education to improve the teaching and learn the process (Li et al., 2022), in addition to preparing future professionals who are more capable of developing innovative technologies and IS solutions. This becomes important because, in Computing courses, students often experience difficulties related to problem-solving and algorithmic thinking (Calderon et al., 2021). Furthermore, students who enroll in IS courses have skills deficits in text interpretation and in subjects such as Portuguese and Mathematics, difficulties that already manifest themselves in high school (Garcia et al., 2017; Saraiva et al., 2020), which impacts the understanding and resolution of algorithmic problems in IS courses. In general, it is believed that block programming can help in the development of 21st Century skills and competencies in high school students, such as logical-mathematical reasoning and computational thinking (Figueiredo and García-Peñalvo, 2017), in addition to promoting student protagonism with more playful activities and challenges.

The assistant ADA Blocks has a set of questions that address aspects such as support material, language, and discipline, among other relevant factors. These questions aim to facilitate the suggestion of block programming tools that are most appropriate to the context of each teacher's discipline. Therefore, a feasibility study was carried out with ten HCI experts, to seek a quick look at the ADA Blocks virtual assistant from experts. Additionally, we would like to highlight that this study seeks to build a body of knowledge about the difficulties of using the ADA Blocks virtual assistant. The feasibility study was chosen because the main objective of the study is not to find a definitive answer but rather to create a body of knowledge about the technology (Shull et al., 2004). The data collection questionnaires used were: a participant characterization questionnaire and a questionnaire adapted from the *Technology Acceptance Model* (TAM 3), defined by Venkatesh and Bala (2008). In general, the results of this study show that ADA Blocks are easy to use and ADA Blocks optimizes the teacher's work and contributes significantly to the area of Information Technology in Education in Computing. It was realized that ADA Blocks can also be used in introductory subjects in higher education courses. A limitation of the assistant is that it is not accessible to blind or visually impaired teachers.

This paper is organized into 7 sections. Section 2 presents related work on the use of block programming in high school. Section 3 addresses the methodology used in the feasibility study. Sections 4 and 5 present the results and discussions of the quantitative data. Section 6 presents the results of qualitative data. Finally, Section 7 presents final considerations and future work.

2 RELATED WORK

Jocius et al. (2020) conducted a training with 116 teachers using the *Snap!*[1] tool. The participants were teachers from the Humanities, Sciences, and Mathematics areas. The training began with PRADA (Pattern Recognition, Abstraction, Decomposition, and Algorithms), addressing computational thinking, followed by code infusion sessions. In this process, the Use-Modify-Create learning structure was adopted, which allowed teachers to use, modify, and create new codes. During the course, teachers developed lesson plans for their respective disciplines and suggested activities that could be implemented in the classroom. In addition, they carried out a collaborative activity to map and describe the patterns of the PRADA elements, in addition to creating teaching materials, such as slides and handouts, to share the knowledge acquired with other participants.

Buffum et al. (2016) used the *ENGAGE*[2] tool for teacher training, employing a game-based learning environment focused on Computer Science. The study had the participation of 18 students and 4 teachers, and was divided into three stages: 1) Development of the curriculum in collaboration with the teachers; 2) Teacher training; and 3) Implementation of the study with students. The teachers expressed satisfaction with the training received and highlighted the support of the game-based learning environment in the classes. On the other hand, the students demonstrated a positive response to the experience, and observations made in the classroom indicated a high level of engagement on their part.

In the study by Seralidou and Douligeris (2019), teachers taught content that included the design and programming of Android applications for mobile devices. Students worked in groups of two or three people on each computer. During each class, teachers gave students activity sheets that mentioned the time available to complete the activity and then observed the students. The researchers monitored high school teachers to evaluate the methodology used in the classroom, both from the teacher's and student's perspectives, and it was noted that students and teachers have a positive attitude towards the implementation and use of the MIT App Inventor[3] software.

[1] https://snap.berkeley.edu/

[2] http://projects.intellimedia.ncsu.edu/engage/

[3] https://appinventor.mit.edu/

The studies mentioned above highlight the use of block programming tools by high school teachers and their students, evidencing positive perceptions regarding their use in the classroom. However, teachers were observed to receive support from researchers during the teaching and learning processes, working with a specific tool. It was not mentioned whether teachers were free to choose the tool most appropriate to their context of use or subject. The lack of teacher autonomy in choosing the block programming tools that best suit their needs can limit and restrict teaching and learning processes, making them inflexible and standardized. In this sense, the existence of an assistant that supports the process of selecting one or more block programming tools was not identified in the literature, offering autonomy to the teacher in choosing the most appropriate tool to meet their needs. For this reason, the ADA Blocks virtual assistant was developed with the objective of helping teachers choose the block programming tools that are most appropriate to their context of use.

3 ADA BLOCKS ASSISTANT

The ADA Blocks virtual assistant consists of a technology that recommends a set of block programming tools for high school teachers. To suggest the tools, the teacher must answer a set of questions in the recommendation questionnaire. After answering all the questions, the ADA Blocks assistant suggests some tools to the teacher.

The recommendation questionnaire has ten questions. These questions were constructed based on the characteristics investigated in a benchmark (Perin et al., 2021). The questions are related to the discipline in which the teacher wishes to use the block programming tool, whether they would like to use support material and what type of material, among others. Among the answers, one can find the disciplines where the block programming tools can be worked, the platforms on which they work, the operating systems, and emerging technologies, among others. The basis for the construction of ADA Blocks was an opinion survey carried out with high school teachers (Perin et al., 2022), a Systematic Mapping of the Literature (SML), and the benchmark (Perin et al., 2021). The recommended tools were those returned in the SML and the manual search on their *web* pages. Only tools that had an access link and allowed the characteristics to be consulted were considered. More details about the ADA Blocks wizard can be found in the technical report [4].

The ADA Blocks assistant questionnaire was divided into two stages: (1st) data entry and (2nd) analysis and recommendation of block programming tools. The first stage (data entry) consists of the teacher's response to the assistant's questionnaire. The recommendation questionnaire has a set of questions where there are at least two possible answers for each question. The questionnaire works as follows: a question, when answered, is directed to the next one based on the answer obtained in the current question. The second stage is the analysis of the answers and the recommendation of tools based on the teacher's answers. The Figure 1 presents the results of a search for block programming tools (screen in Portuguese) recommended by the ADA Blocks virtual assistant.

4 FEASIBILITY STUDY

The feasibility study was carried out as suggested by Shull et al. (2004), whose purpose is to verify whether the objectives of the proposed technology, the ADA Blocks virtual assistant, can be met, before being applied in a real context. A previous study was conducted with high school teachers to assess the adoption and acceptance of the ADA Blocks virtual assistant, which allowed us to create a body of knowledge from the perspective of these teachers (Perin et al., 2022a). As a result, improvements were made to the assistant, making it more effective and aligned with the needs of teachers. From this study, the need arose to conduct a new investigation with HCI experts, to obtain a technical view on the suitability of the ADA Blocks virtual assistant in terms of design, usability, and accessibility, and to identify improvements needed to align the ADA Blocks with its target audience. In this paper, we first seek to create a body of knowledge about the ADA Blocks virtual assistant from the perspective of HCI experts. This study was approved by the Research Ethics Committee[5].

The feasibility study was 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, it was defined that study participants would be invited by e-mail. The steps defined to carry out the study after participant acceptance were: (1) Presentation of the Informed Consent Form (ICF) and the objective of the study, (2) Presentation of the functionalities of the ADA Blocks website, page menus and the

[4]https://figshare.com/s/6e9faa378645d045e712

[5]Federal University of Paraná, Brazil - CAAE: 78743624.0.0000.0102 - Opinion Number: 6.786.195

Figure 1: Result of an ADA Blocks tool search (screen in Portuguese).

ADA Blocks virtual assistant recommendation questionnaire, and (3) Presentation of the data collection questionnaires. For this study, the data collection questionnaire was made available directly on the ADA Blocks website[6], allowing participants to explore the assistant and then answer the questionnaire in the same environment, without the need to access an external platform. Therefore, the data collection questionnaires were defined, namely: a characterization questionnaire and a questionnaire adapted from the *Technology Acceptance Model* (TAM 3), defined by Venkatesh and Bala (2008). The characterization questionnaire contained six multiple-choice questions, to know the profile of the experts, and whether they had prior knowledge about block programming. The questionnaire based on TAM 3 contained ten multiple-choice questions about the perception of experts' acceptance of ADA Blocks. The TAM 3 model was chosen because researchers widely use it and has undergone several experiments that indicate its viability of use (Davis et al., 1989; Venkatesh and Bala, 2008)). In addition, this questionnaire had open fields for participants to comment on ADA Blocks virtual assistant.

The Execution stage (2) took place on Jun/2024, totaling 26 days. In the first contact via e-mail, a summary of the study was presented, and if the teachers wished to participate voluntarily, an online meeting was scheduled according to their availability. During the meetings, ICF was presented, and any doubts that might arise were clarified. Subsequently, the researcher briefly introduced the ADA Blocks virtual assistant. Finally, the experts were instructed to send the signed ICF by email, instructed to use the ADA Blocks virtual assistant and explore its website, and to answer the characterization and evaluation questionnaire at the time they found most convenient within 7 days after the study presentation meeting. The third stage, data analysis, will be presented in the following section.

[6]https://www.adablocks.com.br/

5 RESULTS

Ten HCI experts participated in this study. The results obtained were organized into three parts: (1) Characterization data of the teachers; (2) Quantitative data of the TAM 3 indicators; and (3) Qualitative analysis of the open questions, this third part is presented in Section 6.

5.1 Characterization of the Participants

To characterize the experts of the HCI profile, six questions were asked: (1) Gender; (2) Age; (3) Qualification; (4) Area of activity; (5) Experience in the HCI area; and (6) Whether the expert knew the term block programming before to use the ADA Blocks.

Regarding the gender of the experts of HCI (question 1), 70% (N = 7) are male and 30% (N = 6) are female. Regarding age (question 2), 70% (N = 7) of the specialists are between 20 and 30 years old, 20% (N = 2) are between 31 and 40 years old, and 10% (N = 1) are between 41 and 50.

Regarding qualifications (question 3), 90% (N = 9) of the participants have a master's degree, and 10% (N = 1) have a specialization.

Regarding the type of area in which they work (question 4, Figure 2), 38.5% (N = 5) work in academia as researchers, 30.8% (N = 4) work in academia as professors, 23.1% (N = 3) work in the private sector, and 7.7% (N = 1) work in the public sector.

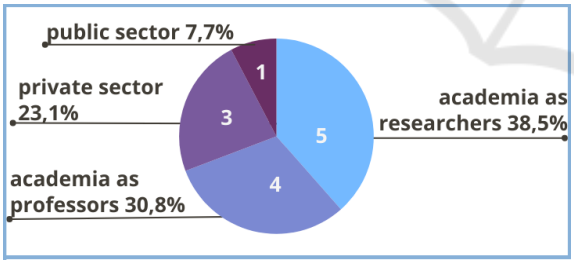

Figure 2: Area in which they work.

Regarding the time of experience in the HCI area (question 5, Figure 3), 30% (N = 3) have been working for 6 years, 30% (N = 2) have been working for 5 years, 20% (N = 2) have been working for 7 years, 20% (N = 2) have been working for 9 years and 10% (N = 1) have been working for 3 months.

Regarding the expert knowing the term "block programming" before knowing the ADA Blocks tool (question 6), 90% (N = 9) responded that they knew the term, while 10% (N = 1) responded that they did not know.

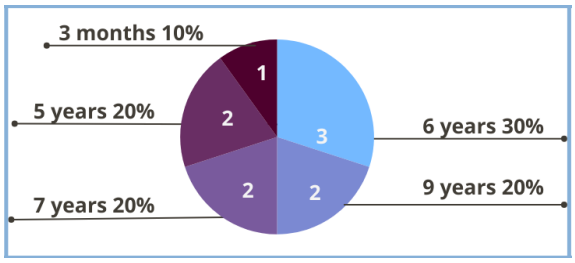

Figure 3: Time of Experience in the HCI Area.

5.2 Acceptance Analysis Using TAM 3

The results regarding the acceptance analysis of ADA Blocks are presented according to the TAM 3 indicators, which are: (1) **Perceived Ease of Use (PEOU)**, which establishes the degree to which a participant believes that the use of a specific technology is easy to use; (2) **Perceived Usefulness (PU)**, which establishes the degree to which a participant believes that the technology can improve his/her performance; and (3) **Future Use Intention (FUI)**, which establishes the degree to which a participant believes that he/she would use the technology in the future.

The indicator (1) Perceived Ease of Use contains the following statements: (PEOU1) My interaction with ADA Blocks is clear and understandable. (PEOU2) Interacting with ADA Blocks does not require a lot of mental effort. (PEOU3) I find ADA Blocks to be easy to use.; and (PEOU4) I find it easy to get ADA Blocks to do what I want them to do, recommend a set of block programming tools for high school teachers. Figure 4 presents the results of TAM3.

The data indicate that most participants fully agreed with the statements related to Perceived Ease of Use (PEOU1 to PEOU2 4), reinforcing the perception that the ADA Blocks virtual assistant is an intuitive and accessible tool. These results highlight that users found the interaction clear (PEOU1), indicating that the interface and navigation flows are well structured; it requires little mental effort to use (PEOU2), suggesting that interactions are intuitive, reducing cognitive overload; it is easy to use (PEOU3) and is efficient in performing specific tasks, such as recommending block programming tools to high school teachers (PEOU4). The ease of use mentioned in PEOU3 and PEOU4 reinforces that participants felt confident in using the tool to achieve their goals. This positive perception can be used strategically to promote ADA Blocks as an effective and accessible solution, both in training for educators and in initiatives for wider adoption in educational institutions.

Even with positive results on PEOU1 to PEOU4, two participants somewhat disagree PEOU1 and one

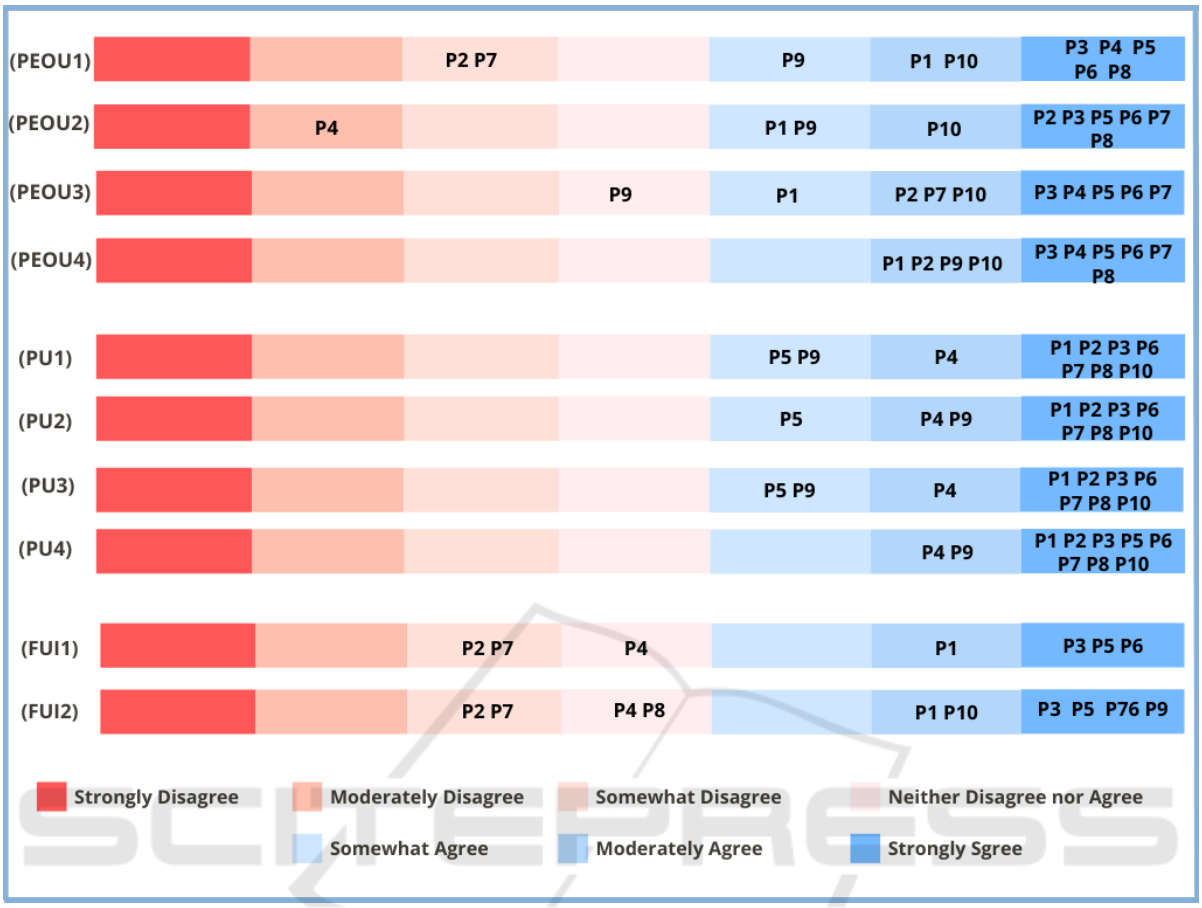

Figure 4: Analysis of participant acceptance of ADA Blocks.

participant moderately disagrees PEOU2. Regarding PEOU3, one participant neither agreed nor disagreed with the statement. To solve some of the difficulties faced by some participants, a tutorial on ADA Blocks could be created, containing instructions for use, thus assisting in the use of the assistant or improving its interface, such as changing the side menu to a top menu. The aim is also to expand the tool's functionalities, maintaining ease of use as a fundamental principle, especially when integrating resources that meet the specific needs of high school teachers.

Regarding the Perceived Usefulness indicator, there are four statements, namely: (PU1) Using ADA Blocks improves my performance in choosing block programming tools that can be used in my high school subject; (PU2) Using ADA Blocks increases my productivity in choosing block programming tools that can be used in my high school subject; (PU3) Using ADA Blocks enhances my effectiveness in choosing block programming tools that can be used in my high school subject; and (PU4) I find ADA Blocks to be useful for choosing block programming tools. It was identified that most participants fully agreed with the statements.

Thus, in Figure 4, it can be seen that most participants fully agreed with the statements, reflecting a positive perception of ADA Blocks. Statement (PU1), which deals with improved performance when choosing tools, suggests that the platform facilitates teachers' decision-making, providing a selection of tools that are more aligned with the needs of their high school subjects. This implies that ADA Blocks contribute to a more efficient and successful selection process.

Statement (PU2) highlights the impact on productivity. The fact that participants consider ADA Blocks to increase productivity indicates that the platform offers a time-saving solution, simplifying the search for suitable tools. By centralizing different options in a single space, ADA Blocks avoids the need to search multiple sources, speeding up the selection process.

Regarding effectiveness (PU3), it reveals that the platform not only facilitates the selection process but also makes it more effective. This suggests that par-

ticipants were not only faster, but also more assertive in their choices, which can be attributed to the suggestions of block programming tools offered by ADA Blocks, which align the options with the users' pedagogical context.

Statement (PU4) about the Perceived Usefulness of ADA Blocks reinforces the perceived value of the platform. Most participants consider it useful, which is a strong indicator that ADA Blocks met the expectations and needs of its users, offering a practical, effective and relevant solution.

In general, the affirmative answers to the four questions reveal that the experts perceived ADA Blocks as a useful tool for high school teachers, improving their performance, productivity and effectiveness in choosing block programming tools. This demonstrates the relevance of ADA Blocks in the educational context.

Finally, the indicator Future Use Intention (3) has two statements, namely: (FUI1) Assuming that I have access to ADA Blocks, I intend to use it; and (FUI2) Considering that I have access to ADA Blocks, I foresee that I would use it. In general, participants responded positively about the future use intention (FUI1 and FUI2 - Figure 4). It can be observed that one participant remained neutral (neither disagree nor agree) about the statement FUI1 (P4) and two remained neutral (neither disagree nor agree) about the statement FUI2 (P2 and P7). In addition, (P2 and P7) somewhat disagreewith FUI1 and UF2.

It can be seen that most of the participants expressed a positive intention for future use, with agreement on both statements. The positive intention for future use is a good indication that the ADA Blocks virtual assistant has been well received and meets the needs of the participants, stimulating interest in continuing to use it.

However, P2 somewhat disagree with the statements UF1 and UF2 can be attributed to the fact that not all participants are specialists working directly in teaching. Participant P7 works in the private industry. Regarding P7 somewhat disagrees with the statements UF1 and UF2, which can be attributed to the fact that he does not work as a high school teacher, not seeing the need for their future use; however, he sees the usefulness of ADA Blocks.

In addition, the broad disagreement of P2 and P7 with both statements UF1 and UF2 suggests that, for these participants, ADA Blocks do not fully meet their expectations or needs. In this case, one way to improve the future usage intention of these participants may be through adjustments to ADA Blocks, whether in the interface, in the personalization of recommendations, or in the functionalities offered.

6 QUALITATIVE ANALYSIS AND DISCUSSIONS

For qualitative analysis, the partial procedures of the *Grounded Theory* (GT) method (Corbin and Strauss, 2014) were used. GT has 3 stages in the coding process, namely (1) open coding, (2) axial coding, and (3) selective coding. In open coding, the participants' feedback was coded. In axial coding, the codes were grouped according to their properties and related to each other, thus forming categories that represent their characteristics. Selective coding was not performed, it is not possible to create a theory, since a circularity of the data is necessary through more studies. The responses received were analyzed and coded individually, and peer-reviewed.

Regarding the **difficulties** encountered, difficulties related to the design of ADA Blocks can be mentioned (see the quote from P2 below); difficulties returning to a previous question while answering ADA Blocks questions (see P6 and P7a quotes below); difficulties related to texts being too close to the horizontal and colors being off-standard in some ADA Blocks elements (see P7b quote below); difficulties related to the ADA Blocks menu icons (see P9 quote below); and difficulties using ADA Blocks in a mobile browser (see P10 quote below).

"The biggest difficulties are in the design of the tool (P2)".

"I encountered difficulties when trying to return to a previous option while answering the ADA Blocks questions (P6)".

"Impossibility of returning to a question in the questionnaire (P7a)".

"Texts too long horizontally... Use of non-standard colors in some elements (P7b)".

"The way the menu icons are arranged made me try harder to identify 'where' I was on the page and 'where' I wanted to go (P9)".

"There were some obstacles in mobile use (P10)".

One way to solve or minimize the difficulties pointed out by P2 and P9 is to redesign the ADA Blocks virtual assistant, repositioning the main menu from the side to the top of the page and its content being structured by tabs, rather than continuous scrolling. Furthermore, it is essential to highlight the menu icons, making them more visible and understandable for users, which will make it easier to locate and navigate the interface. With this change, it will be possible to adjust the texts to more appropriate and standardized sizes, in addition to optimizing the colors, which was a difficulty mentioned by P7b. One way to solve the difficulty of returning to the previous question (P6 and P7a) would be to implement

an option that allows the user to return to the previous question with a simple click, whenever necessary.

Regarding the **limitations of ADA Blocks**, limitations such as not providing details on how to use the block programming tools and how to apply them in a teaching plan (see the quote from P5 below) and suggestions for applying ADA Blocks in a real scenario (see the quote from P9 below) can be mentioned.

"There are no details on how to use the block programming tools, how to apply them in a teaching plan (P5)".

"...I suggest applying them in a real scenario to evaluate their usefulness (P9)".

One way to minimize the limitations of ADA Blocks related to P9's comment would be to provide support materials, such as tutorials, class videos, teaching plan models developed by other teachers who have already used the block programming tool suggested by ADA Blocks, as well as discussion forums on how to apply the tool in a teaching plan. Regarding the suggestion to apply ADA Blocks in a real context (P9), the authors consider conducting a study with high school teachers, in which the block programming tool suggested by ADA Blocks is used, taking into account the context of the use of both teachers and students. In addition, the study would also evaluate the results obtained with the use of the tool and the usefulness of ADA Blocks in this process.

Regarding the **suggestions for improvement**, the following can be mentioned: a suggestion to add tools to assist elementary school teachers in a future version (see the quote from P1 below); a suggestion to add buttons to "select all" and "deselect all" in the questionnaire recommending block programming tools (see the quote from P5 below); a suggestion to add other topics to ADA Blocks in addition to block programming (see the quote from P9 below); a suggestion to include suggestion options where users can complement information about other tools to be used and to include a section where users can comment on their experiences using the tools (see the quote from P10 below).

"... here's a tip to also think about elementary school, perhaps in a second version of ADA Blocks (P1)".

"There could be some buttons to "select all", "deselect all" (P5)".

"It would be interesting to add other topics. In addition to block programming (P9)".

"Perhaps it would be interesting to include suggestion options so that users themselves can complement information about other tools to be used... a section where users comment on their experiences using the tools, such as a forum for questions, exchange of ideas, tutorials, among others. (P10)".

Regarding the suggestion for improvement of P10, the intention is to create a knowledge base containing block programming tools that can be used in elementary school and recommended by ADA Blocks. This knowledge base will allow teachers to access a variety of block programming tools that can be used according to the needs of their students and the pedagogical context. In addition, the aim is to provide detailed descriptions of each tool, its functionalities and application examples, discussion forums, and support materials. In this way, ADA Blocks can facilitate the choice of the best solution for different levels of education and educational realities.

Regarding the improvement suggestion mentioned by P5, the aim is to add a button to the recommendation form that allows the user to select all options or not, but only in specific questions, such as language, platform, and operating system. Not making this button available for all options can ensure that the tool filter performed by the ADA Blocks virtual assistant works correctly. This is because ADA Blocks was developed to suggest the most appropriate tool for the characteristics and context of the use of the teacher in the classroom. The filter is essential, for example, to prevent a teacher from selecting all high school subjects to work with block programming or all emerging technologies. In this way, the system ensures that recommendations are personalized, and aligned with the specific objectives and needs of each teacher.

Regarding P9's suggestion, the aim is to incorporate options based on auditory and tactile languages for the visually impaired into the block programming theme, as identified by Psycharis et al. (2022) as being the most appropriate. In addition, a knowledge base will be created that compiles studies and tools for programming in tangible and inclusive blocks, such as CodeRhythm, developed by Rong et al. (2020), and BrailleBlocks, designed by Gadiraju et al. (2020). This approach aims to expand access to programming for people with visual impairments, promoting inclusion and engagement in learning emerging technologies.

Finally, regarding P10's suggestion, the aim is to add to the web page of the ADA Blocks virtual assistant the option for users to share their experiences with the tools recommended by ADA Blocks. This can be done through a discussion forum, in addition to allowing teachers to include support materials, such as tutorials and teaching plans that they have developed. This functionality aims to create a collaborative space, where teachers can exchange knowledge and contribute to the continuous improvement of the

assistant.

Regarding **suggestions for improving the accessibility of ADA Blocks**, suggestions include accessibility options that are missing, such as alternating contrast between Light and Dark, and inserting an "Accessibility" section in ADA Blocks with more information that would be useful (see the quotes from P10 below); suggestions to check whether the captions provided by the video platform allow HandTalk to read and interpret them for users; and suggestions to integrate HandTalk into tutorial videos (see the quotes from P6 below).

"...include missing options, such as toggling between Light and Dark contrast (P10)".

"Perhaps a section on the "Accessibility" website with more information would be useful (P10)".

"I don't know if the subtitles provided by the video platform allow the software to read and interpret them for users; this possibility would need to be verified (P6)".

"As a suggestion for improvement, it would be advantageous to integrate Hand Talk into the tutorial videos (P6)".

To meet P10's suggestion, the aim is to implement toggling between light and dark modes in the redesign of the ADA Blocks virtual assistant. This functionality aims to improve the accessibility of the tool, allowing users to adjust the interface according to their preferences and visual needs. In addition, an item called "Accessibility" will be added to the main menu, which will provide information on the topic and explain how the ADA Blocks assistant meets accessibility criteria, with a focus on promoting inclusion.

Regarding video captions, the intention is to reformulate the videos and their content to make them more interactive, adjusting the size of the subtitles to meet the needs of the visually impaired. In addition, a sign language interpreter will be included, ensuring accessibility for the hearing impaired as well as providing a more inclusive experience for all users. This reformulation would meet the suggestions for improvements made by P6.

Regarding the **perceptions of accessibility of ADA Blocks**, the following can be mentioned: auditory descriptions of images for interpretation using screen reading software (see the quote from P6 below); ADA Blocks provides a sign language translator (see the quote from P7 below); and the participant liked the accessibility tools, such as the sign language plugin (see the quote from P10 below).

"[...] When examining the HTML code of the application, the presence of audible descriptions for the images was noticed. This functionality is of great importance, as it facilitates the interpretation of images by people with visual impairments, using screen reading software. (P6)".

"ADA Blocks provides a sign language translator (P7)".

"I liked the accessibility tools, such as the sign language plugin (P10)".

The perceptions about the accessibility of the ADA Blocks virtual assistant highlight important resources to promote inclusion. The presence of auditory descriptions for images, mentioned by P6, facilitates the interpretation of visual content by visually impaired people, using screen reading software. The provision of a sign language translator (P7) is another relevant aspect, ensuring access to content for people with hearing impairments. The quote from P10 expresses the satisfaction of users with these accessibility tools, such as the sign language plugin. These resources are essential to make ADA Blocks a more inclusive tool, offering equal access to knowledge and technology for people with different needs.

Regarding the **perceptions about the usefulness of ADA Blocks**, the usefulness throughout the interaction can be mentioned, especially in terms of digital accessibility (see the quote from P6 below); useful when there is a need to find the best tool to work on a certain subject; and useful and brings benefits to the user who was not familiar with the term "block programming" (see the quote from P3 below).

"The usefulness of the ADA Blocks assistant has been extremely positive for me throughout my interaction with it, especially in terms of digital accessibility (P7)".

"ADA Blocks is very useful when we need to find the best tools for a given subject[...] and brings benefits since I was not familiar with the term [block programming](P3)".

The perceptions about the usefulness of the ADA Blocks virtual assistant highlight its importance in terms of digital accessibility and choosing appropriate tools. According to P7, ADA Blocks have proven to be positive, especially when offering accessible resources for different users. The virtual assistant has also proven to be useful for finding the best block programming tool to work on a given subject, as mentioned by P3, helping in the choice of block programming tools according to the context of use. In addition, ADA Blocks brings benefits to users who were not familiar with the concept of "block programming", promoting digital inclusion and the learning of new skills.

Regarding **perceptions about ease of use of ADA Blocks**, we can mention the ease of navigation and interaction with digital applications, essentially for peo-

ple with special needs (see the quote from P6 below); and the ease of using ADA Blocks (see the quote from P3 and P10 below).

"I understand that ADA Blocks significantly facilitates navigation and interaction with digital applications, something essential for people with special needs (P6)".

"The tool is easy to use (P3)".

"I found the tool easy to use (P10)".

The perceptions about the ease of use of ADA Blocks highlight its simplicity in navigation and interaction with digital applications, especially for people with special needs. As mentioned by P6, ADA Blocks facilitate the interaction of users with skills, ensuring a more accessible and intuitive experience. This accessibility is crucial to ensure that everyone can use the tool independently, regardless of their limitations.

In addition, the ease of use of ADA Blocks is also highlighted by P3 and P10, who highlight how the platform is simple to use, providing a pleasant experience from the beginning. These perceptions indicate that ADA Blocks are designed to be accessible to a wide range of users, with a focus on simplicity and effectiveness of interaction, which is essential to ensure that everyone, including those with disabilities, can make the most of its functionalities.

Regarding **perceptions about the future use of ADA Blocks**, the following can be mentioned: the participant intends to use ADA Blocks to prepare material for his first-year college class (see the quote from P3 below); and finally, the participant believes that there is great potential for expanding ADA Blocks (see the quote from P10 below).

"I have beginner programming classes at the College, and I intend to use it to prepare material for these classes. (P3)".

"I believe that there is great potential for expansion in this project, congratulations to the researchers (P10)".

The perceptions about the future use of ADA Blocks highlight a positive view regarding its potential for application and expansion. The quote from P3, in which the participant expresses the intention of using ADA Blocks to prepare material for his first-semester classes at the College, reflects the usefulness of the tool in the context of higher education. Thus, it demonstrates that ADA Blocks are useful to help create material for beginner programming courses and have a practical application in academic environments, especially in introductory programming disciplines. This suggests that the tools suggested by ADA Blocks can be used to teach basic programming concepts, providing an accessible and dynamic teaching resource.

Furthermore, P10 believes in the potential for the assistant to expand, indicating an even more optimistic view of the future of ADA Blocks. The perception that the assistant can grow and reach more users indicates that there is recognition of its value and an expectation that it will become more popular and widely used, both in primary and higher education. This may involve adapting the tool to different audiences, improving its functionalities, or expanding its use to other areas of education and even outside the academic context, reaching users who seek to learn programming or improve their digital skills.

Taken together, these perceptions suggest that ADA Blocks have significant potential for future application, both in higher education, as demonstrated by P3's quote, and on a larger scale, as indicated by P10's quote. This reflects a vision of growth for the tool, with the possibility of becoming an even more robust and accessible platform, meeting a wider variety of educational needs and expanding its impact on programming learning.

Regarding the **characteristics perceived by participants**, we can mention the difficulty of finding a place that brings together several block programming tools in one place (see the quote from P2 below); ADA Blocks user-centered approach increases user satisfaction and reinforces trust in the platform as an innovative and reliable solution (see the quote from P6 below); and ADA Blocks provides a questionnaire that helps teachers choose block programming tools in addition to not requiring downloading or installing programs (see the quote from P7 below).

"It is difficult to find a place that brings together all these tools in one place (P2)".

" This user-input approach not only increases my satisfaction but also reinforces my confidence in the platform as an innovative and reliable solution (P6)".

"It provides a questionnaire that helps those teachers who may not understand the specificities of each tool...it is possible to access it via the web (no need to download/install programs) (P7)".

The characteristics perceived by the participants about the ADA Blocks virtual assistant highlight fundamental aspects that contribute to its effectiveness and attractiveness, especially in an educational context. The quote from P2, which highlights the difficulty of finding a place that brings together several block programming tools, points to a significant gap related to educational resources. ADA Blocks fills this gap by bringing together several block programming tools in a single platform, facilitating the search and choice of appropriate tools according to the teacher's context of use. This simplifies the selection process and provides teachers with a centralized

solution without having to explore multiple websites and platforms, which saves time and effort.

P6 highlights ADA Blocks's user-centric approach, which is a key point for its acceptance. By placing user needs and preferences at the center of the tool's design, ADA Blocks not only improves the user experience but also strengthens participants' trust in the platform as a reliable and innovative solution. This suggests that personalization and adaptation to users' needs are valuable aspects, making the tool more attractive and useful in the long run.

Furthermore, P7's quote reveals that ADA Blocks provides a questionnaire that helps teachers choose the best block programming tools, without the need for in-depth technical knowledge. This can be important for teachers who may not be familiar with the specifics of the different tools. The ease of access to the platform, without the need to download or install programs, is also a positive point, as it eliminates technical barriers and allows users to start using the tool immediately, directly via the web.

Overall, the characteristics perceived by participants highlight ADA Blocks as a practical, user-centered and accessible platform, which meets a real need for centralization of block programming tools and facilitates the process of choosing educational tools. These factors contribute to a more satisfactory, reliable and efficient experience for teachers.

7 FINAL CONSIDERATIONS AND FUTURE WORK

The results of the study demonstrate that the ADA Blocks virtual assistant has great potential to assist high school teachers in choosing block programming tools, promoting efficiency, practicality and greater autonomy in pedagogical planning. The quantitative analysis revealed a largely positive perception regarding ease of use and perceived usefulness, indicating that the platform can answer the needs of teachers in choosing block programming tools. However, challenges related to accessibility and some limitations in the interface, such as navigation on mobile devices and the inability to return to previous questions in the questionnaire, were identified. These limitations offer opportunities for improvement, especially in the design and functionalities of the platform.

One limitation of the study is the small number of participants, only 10 HCI experts. A small sample size may limit the diversity of perspectives and the generalizability of the findings. Furthermore, detailed data on the profile and expertise of the participants were not collected, such as their areas of HCI specialization (Usability, accessibility, user eXperience), 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. Finally, the lack of clear criteria for selecting participants may have impacted the quality of the data, since experts with different areas of expertise may prioritize different aspects, influencing the results in a non-uniform manner.

In future work, we intend to redesign the interface of the ADA Blocks virtual assistant, standardize the colors, and adjust the font sizes so that they are suitable for the most diverse users. The aim is also to include support materials for the use of block programming tools suggested by ADA Blocks, in addition to developing collaborative features to promote user interaction, exchange of materials and experiences, and strengthening interaction and community learning. The development of this feature can expand the impact of ADA Blocks in the educational field. In addition, the aim is to integrate and increase the knowledge base, adding inclusive resources, such as tools for the visually and hearing impaired, and the incorporation of topics beyond block programming, such as tactile languages. In this way, the accessibility and scope of the platform can be expanded. The aim is also to conduct future studies focusing on the application of ADA Blocks in real classroom scenarios, analyzing the direct impact on students and teachers, in addition to exploring its use at elementary and higher education levels.

Finally, ADA Blocks represents a promising initiative for the development of 21st-century skills, such as computational thinking, problem-solving and student leadership. Its success depends on continuous efforts to adapt and expand its functionalities, making it a robust and accessible solution for education. With the proposed adjustments and improvements, the platform can consolidate itself as an essential tool in teaching block programming, contributing significantly to innovation in the educational field.

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