ASD: Interaction and socialisation through an adapted social network

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Abstract

Epidemiological studies have demonstrated a significant increase in the incidence of Autism Spectrum Disorder (ASD) in the population over the years. Estimates indicate that approximately 1% of children worldwide are diagnosed with autism, while in the United States, this ratio is 1 in every 36 children. Additionally, research suggests a growing interest in technology among autistic children, with the use of computing devices showing potential for the development of social and emotional skills. Digital technology is widely recognized for playing a crucial role in promoting social inclusion and improving the quality of life for people with disabilities. In this context, social networks offer a virtual environment for entertainment and interaction among various groups of individuals. This project aims to present a social network platform specifically developed for adolescents with Autism Spectrum Disorder. The project incorporates various accessibility concepts and strategies to promote interaction and socialisation among community members. Usability and accessibility evaluations were conducted in different ways. First, an initial usability test, conducted within the scope of the tool's development, involved two students and a professor in the field of HCI. Subsequently, the usability of the social network was evaluated by three specialists using Nielsen's heuristic evaluation technique, revealing few usability issues, as presented in this article. Furthermore, usability inspections were conducted using automated tools, identifying x issues, as described in the text. Finally, a test with an ASD specialist was conducted, whose considerations indicate good clinical use prospects for the tool, which are detailed in this article.

Keywords: Autism Spectrum Disorder (ASD); Digital Technology; Social Inclusion; Accessibility; Usability Evaluation.

1 Introduction

Epidemiological studies have shown a significant increase in the prevalence of Autism Spectrum Disorder (ASD) in the population over the years [1]. According to estimates, 1% of children worldwide are diagnosed with autism [2]. In the United States, 1 in every 36 children is autistic, which corresponds to approximately 2.8% of the American population [3]. Numerous studies have indicated a correlation between autism and genetic factors, suggesting the continuity of the disorder in future generations [4].

Autism is a disorder associated with the neurodevelopment of individuals [5], characterized by deficiencies in three main domains: social interaction, language, and interests [6]. Although genetic studies have revealed a significant contribution of genetic factors in the etiology of autism [7], autism is considered a disorder resulting from multiple causes [8].

Digital technology plays a fundamental role in facilitating the social inclusion and community life of people with disabilities [9]. In this context, children with Autism Spectrum Disorder have shown an interest in using computational devices such as cell phones, tablets, and electronic games, making these resources increasingly adopted in the therapies and educational procedures for these children [10].

Research has indicated that the use of computational devices shows promise for improving the social and emotional skills of individuals with autism [11]. Similarly, a study reported that a computer-based learning system facilitates the linguistic development of autistic children [12].

Thus, the objective of this study is to develop a social network adapted for people with autism to develop communication and social interaction skills in their daily lives. The tool underwent four types of evaluation: an initial usability test, involving two students and a professor in the field of HCI; a heuristic evaluation conducted by three usability experts; an automated usability and accessibility inspection; and a content evaluation performed by an ASD specialist.

The study is organized as follows: Section 2 covers the theoretical foundations of autism and interface accessibility, as well as related works; Section 3 presents the development of the social network divided into stages, which are: requirements analysis, design and implementation; Section 4 presents the four types of system evaluation; and Section 5 contains the conclusions of the study.

2 Theoretical Foundations

2.1 Autism Spectrum Disorder

Autism Spectrum Disorder is composed of various complex neurodevelopmental conditions that become evident in childhood [13], characterised primarily by deficiencies in the quality of communication and social interaction, restricted interests, and repetitive behaviours [14]. Typically, symptoms are noticeable by the age of 3, but research shows that it is possible to identify them between 6 and 18 months of life [15].

Neurobiological research forms the basis for multiple theories. In this regard, an increased total brain volume, inferred from head circumference size, is highlighted as being correlated with the presence of autism [16]. Similarly, an investigation using neuroimaging indicated abnormalities in the cortical thickness of people with autism, particularly in the temporal lobe of the brain, which aligns with previous investigations that had already pointed to anomalies in this brain structure in autistic individuals [17].

Autism is considered a multifactorial disorder, as various risk factors contribute to the development of the phenotype [18]. An increased risk of autism is associated with advanced parental age, a maternal history of autoimmune diseases, maternal infections or immune activation during pregnancy, and premature birth [19]. Also, it has a well-established genetic link [18] and it is likely that multiple genes play a role in this disorder [14].

Studies indicate a prevalence of autism of 1 in every 100 children [2]. Additionally, the disorder is more common in males, but recent analyses have shown that the male-to-female ratio was approximated from 4:1 to 3:1 [19]. In the United States, Autism Spectrum Disorder is considered one of the most concerning conditions in terms of neurodevelopment. In this country, the total annual expenditure related to autism is estimated at 250 billion dollars, and an individual with autism may spend up to 2.5 million dollars throughout their lifetime [5]. Autism Spectrum Disorder (ASD), as described in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [20], introduced several significant changes in its characterization and diagnostic criteria. Among these modifications, the emphasis on interaction and the functional use of communication stands out. The DSM-5's new approach highlights persistent deficits in communication and social interaction across various contexts. Thus, communication for social interaction, which involves non-verbal aspects, has come to be referred to as Social Communication.

Understanding a message does not depend solely on linguistic elements; it is essential that the interlocutor also considers contextual factors and their world knowledge [21]. Pragmatic comprehension refers to the ability to use context to interpret information, constructing meaning by connecting pieces of information [22]. Pragmatic skills play a crucial role in the development and maintenance of interpersonal relationships and communication in different contexts [23]. The rules of Social Communication are acquired through interaction and require a refined system of attention to context and the interlocutor. They relate to what, how, and when we communicate with different people, in various contexts, and in multiple interaction situations. Furthermore, they encompass facial expressions, gestures, and other non-verbal cues that we use to convey perceptions, feelings, and nuances of meaning [24].

Specifically, in the context of ASD, research on language impairments in children with ASD from a pragmatic perspective has revealed that the core of language difficulties lies precisely in its functional aspects [25]. This aspect continues to be highlighted by many scholars as a common language characteristic in individuals with ASD [26]. The description proposed by the American Psychiatric Association in 2013 for Level 1 severity in ASD serves as an example of social communication impairment. ASD Level 1 severity: Requires support. Noticeable impairment without support; difficulty initiating social interactions, atypical or inappropriate responses to social overtures; little interest in social interactions; attempts to make friends are odd and usually unsuccessful [24].

Pragmatic skills and social communication begin in childhood but continue to develop through adolescence and adulthood, with challenges and specific characteristics in each stage. In this context, the number of studies focused on adolescents and adults with ASD has increased, as well as the demand for guidance and support related to social and professional activities.

2.2 Interface Accessibility

Accessibility is a concept associated with inclusion, where everyone has the same right to access a particular product. In this sense, the interface should be developed with all people in mind [27], ensuring that any user can interact with the content available on the web and ensuring that no individual is excluded from society due to their limitations [28]. During the application development, there are best practices to be considered. Regarding autistic individuals, it's important to consider typography, fonts, and font size. In this sense, the ideal is to use sans-serif fonts, differentiating between uppercase and lowercase letters. Similarly, avoid using variations such as italics, handwriting, shading, vertical text, also taking care with the size of letters, figures, and symbols, which should be proportional to the reading distance. In addition to typography care, information needs to be clear, objective, and complete, with the highest visibility possible, ensuring that all functions are within the user's field of vision and providing self-explanatory text [29].

Furthermore, it's also important to consider the concept of usability. Usability is used as a parameter of efficiency, effectiveness, and satisfaction of the product, through tests with potential users, heuristic evaluation, and review of usability guidelines with the aim of improving the system [27][30].

Regarding usability testing, there are various types of evaluations such as: in laboratories, which are conducted in controlled environments for designers and developers to understand the difficulties in using the system; in natural environments, where the system is released for use; and userless evaluations, where consultants express opinions based on studies and knowledge [30][31].

2.3 Related Works

In the literature, there are several studies on technological resources for people with Autism Spectrum Disorder. In this context, Hijab et al. [32] conducted a study in which accessibility features were added to a messaging application, aiming to investigate the effects on communication and socialization of autistic individuals. Thus, seven people with autism participated in the study over a period of 10 to 16 weeks. In summary, the study concluded that the accessibility features of the application can enhance the communication and social skills of individuals with autism.

Ntalindwa et al. [33] conducted a study in which a mobile application was developed to improve the calculation skills of individuals with autism. In this regard, a participatory design approach was adopted involving 40 children with autism, 10 parents of autistic children, and five teachers who participated in focus group discussions and usability tests. In conclusion, the study developed a mobile application with optimized design based on the information provided by parents and teachers, making it possible for individuals diagnosed with autism to enhance their calculation skills.

Aziz et al. [34] developed an educational application for children with autism aiming to address issues with verbal communication. In this way, the autistic child interacts with a specific figure and then learns through an audio prompt. In summary, this technological application contributes to the learning of autistic children and assists parents in understanding the needs of their diagnosed autistic children, thereby preventing communication breakdowns.

Veríssimo et al. [35] developed a digital game based on social cognition for psychologists to teach these skills to teenagers with Autism Spectrum Disorder. In this project, individuals with autism interact with everyday situations

through mobile devices, with a focus on speech training through voice recognition. In summary, the study concluded that the project contributes to the effort to develop social skills in autistic teenagers.
Thus, this work aligns with the study by Hijab et al. [32] by applying accessibility features to facilitate the interaction of autistic individuals in the application and thereby enhance their social skills. In this project, the solution presented was based on research conducted with autistic teenagers and adults, differing from the study by Ntalindwa et al. [33], which used the participatory design approach. Similar to the application developed by Aziz et al. [34], the aim of this work is to address communication problems; however, the autistic individual interacts with specific posts on a topic of interest instead of figures. As in the study by Veríssimo et al. [35], the solution in this project is based on concepts of social cognition for the communication and socialization of people with autism.

3 Development

3.1 Description

This project was developed between August and December 2023 and involved a team of four Computer Science students. The project is part of the Human-Computer Interaction (HCI) and Software Engineering Laboratory courses at Mackenzie Presbyterian University course. The HCI course employed the Problem-Based Learning (PBL) methodology to teach both the theoretical and practical aspects of the course. In the context presented, the PBL methodology was combined with the development of software on a social theme, which served as the semester project for the students. The group developed a social network for autistic adolescents, named Hola, after researching the lack of technologies for this age group of people with ASD.
The social network named "Hola" was created for people with Autism Spectrum Disorder (ASD), aged between 14 and 30, who face difficulties in communication and socialisation. The aim is to stimulate and facilitate communication among them, making it smoother and more accessible. Additionally, the social network is based on topics, allowing users to address specific subjects of their interest, generating more engagement and interaction with other users.
This project was developed following an iterative software development approach, combining features of both top-down and bottom-up development. The aim is to generate versions (or prototypes) that are progressively refined until an implementation version is achieved, which meets the initially identified requirements [36]. In this type of approach, the success of the project relies on the designers understanding who their users are, on the team working collaboratively, and on creating and testing various versions quickly. Below are the phases of the project's development.
Following the approach proposed by [30], the project went through 10 stages of PBL, starting from brainstorming to decide the theme, and culminating in the evaluation of the group's performance by the professor and an informal evaluation by the students regarding the course. Due to their excellent performance, the group was invited to write an article about the project. Following the syllabus of the Human-Computer Interaction course, in which this work was developed, and the PBL (Problem-Based Learning) methodology, the project deliverables included: user profile, personas, requirements list, UML diagrams, screen prototypes, and scenarios. Subsequently, the project was coded in the chosen programming language (as presented below), a manual was designed, and an implementation report was written. The usability evaluation phase of the project was carried out afterward. This phase is described in section 4.

3.2 Requirements Analysis

Foregrounded were the user's needs, which involve the difficulty in communication and socialisation among individuals with autism. Bearing this in mind, the idea of the social network emerged to stimulate these needs through interactions based on topics of interest.
In this sense, accessibility concepts were employed, such as more suitable colours, reduced visual clutter, and content organisation to facilitate access and interaction. It is worth noting that the social network was designed to be minimalist, with all content organized vertically and every symbol accompanied by explanatory text.
Additionally, a pre-test questionnaire was created with the aim of understanding the personal characteristics and the potential users' relationship with technology.
Then, a list of functional and non-functional requirements separated by priority was built with the aim of visualising all project functionalities, as shown in Tables 1 and 2.

Table 1: List of functional requirements. Source: Authors.

Functional Requirements	***Description***
FR1	User must be able to request access to the system
FR2	User must be able to create a profile

Functional Requirements	*Description*
FR3	User must be able to edit their profile
FR4	User must be able to login
FR5	User must be able to post on the social network
FR6	User must be able to react to posts
FR7	User must be able to comment on posts
FR8	User must be able to follow topics of interest
FR9	User must be able to follow other users
FR10	User must be able to provide feedback on the system
FR11	The system must present a timeline of posts

Table 2: List of non-functional requirements. Source: Authors.

Non-functional Requirements	*Description*
NFR1	The system must be accessible via the web
NFR2	The system must restrict registration to individuals with communication difficulties (level 2 autism), aged 14 and above
NFR3	The system must have a simple, intuitive interface free from excessive visual distractions
NFR4	The system must be multi-user
NFR5	The system must be used on desktop web
NFR6	The system must ensure anonymous data in surveys

With the aim of better understanding the user's relationship with the system and illustrating which external elements interact with the functionalities of the social network, the Use Case Diagram (Fig. 1) was created.

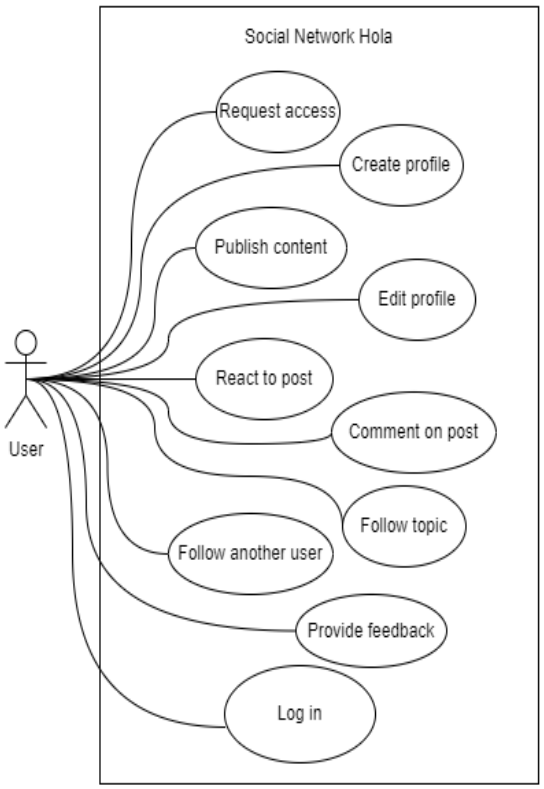

Figure 1: Use Case Diagram. Source: Authors.

3.3 Design

The application was developed considering a microservice architecture, where two services were implemented: social and admission. The social service is responsible for all the interactions of the user with the social network and the admission service manages the new users of the website. Both microservices were developed in Python language, using Flask framework. Also, two Python libraries were used: Marshmallow and SQLAlchemy. The first library manages the schema of requests and responses; the second offers an abstraction of the database for operations over the data.

Additionally, both relational and non-relational databases were used. PostgreSQL was chosen as the technology for the relational database, while MongoDB was used for the non-relational database.

Regarding the front-end, React was predominantly used in the JavaScript language with the JSX extension, provided by React to enable the use of HTML code alongside JavaScript. Finally, Docker containers were used to package the application components, i.e., the microservices and the interface.

In Figure 2, you can visualise the software architecture and infrastructure of the project described above.

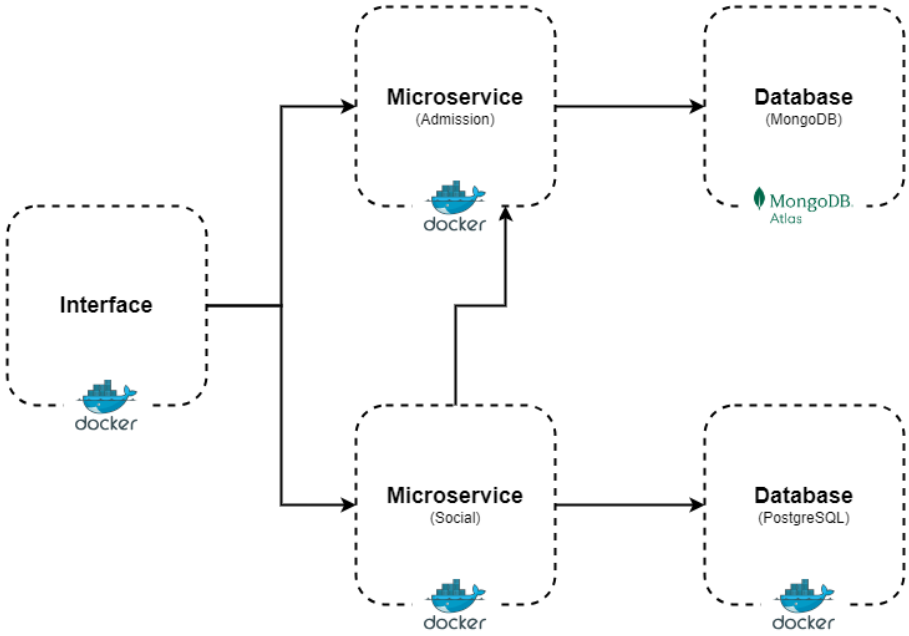

Figure 2: Architecture Diagram. Source: Authors.

3.4 Implementation

After prioritising the requirements and selecting the technologies, the project was prototyped and implemented. The following figures present the screens developed for the social network.
The application starts in Figure 3, on an introductory page to the website, where it's possible to request access or log in if the person already has an account. If the person doesn't have an account, the system directs them to the access request page (Figure 4), where an email and access code are requested. Once these details are validated, the user is directed to the next page, creating an account (Figure 5). After filling in the information correctly, the account will be created. After that, it's necessary to log in (Figure 6) to the social network. If the person already has an account, it's only necessary to log in.

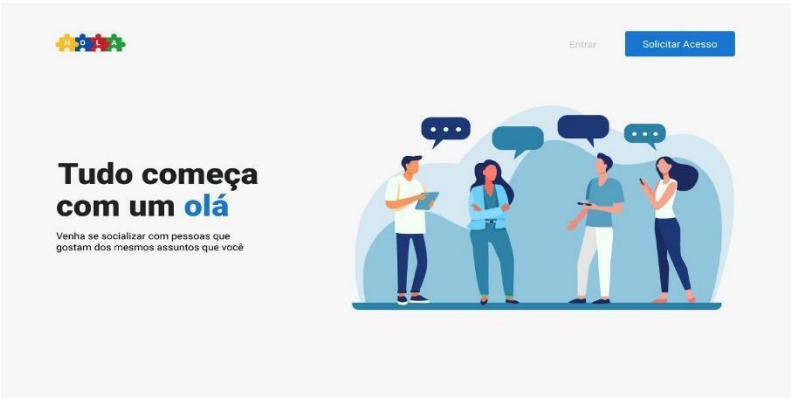

Figure 3: Website's Home Page: Hola (Social Network Name) / Log in / Request access / Everything starts with a hello / Come socialise with people who share your interests. Source: Authors.

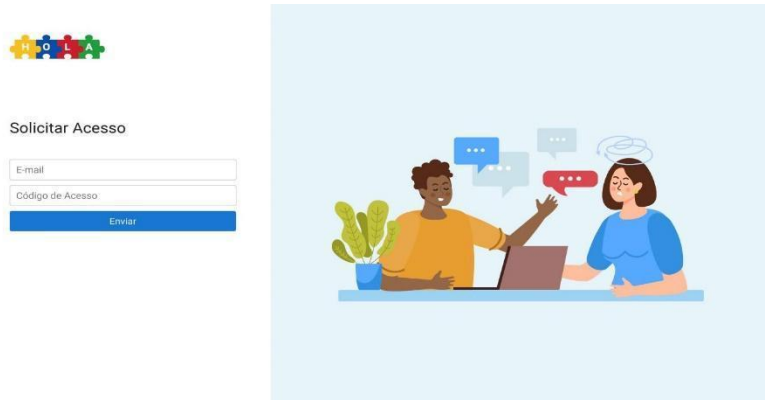

Figure 4: Request Access: Hola (Social Network Name) / Email / Access code / Send. Source: Authors.

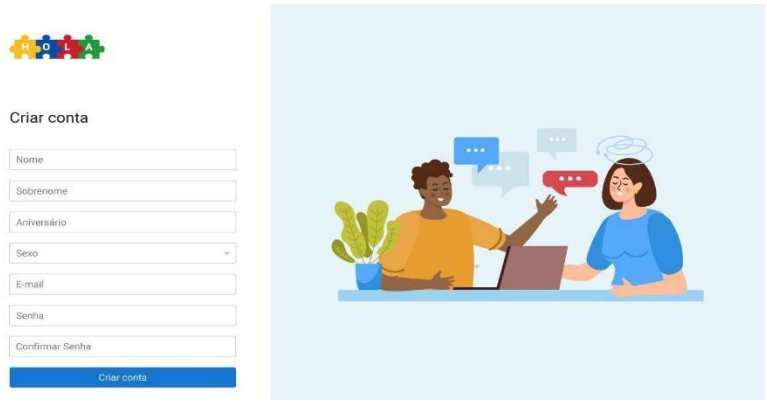

Figure 5: Create Profile: Hola (Social Network Name) / Create account / Name / Last name / Birthday / Gender / Email / Password / Confirm password / Create account. Source: Authors.

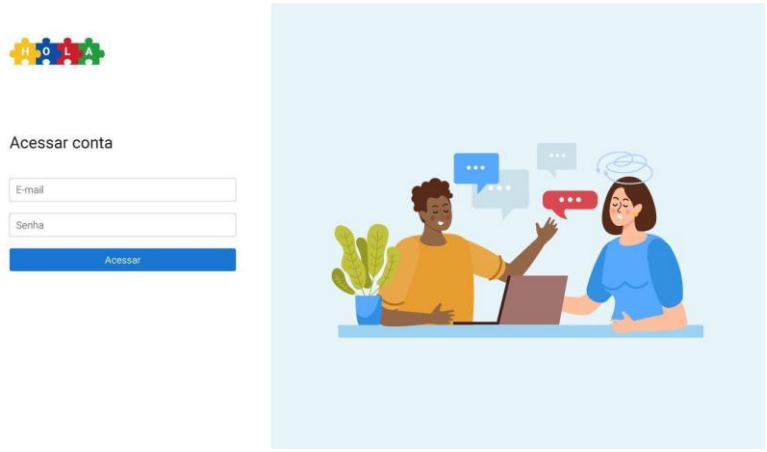

Figure 6: Log In: Hola (Social Network Name) / Access account / Email / Password / Access. Source: Authors.

Once the user is logged in, they can view the timeline (Figure 7) of the social network, where they can see the area for creating a post based on their topics of interest and the posts from the following topics. On this page, it's possible to navigate to other pages of the social network. By clicking on topics in the side menu, the user will be directed to the topic listing page (Figure 8), where they can view all available topics, follow them, and enter a specific topic page (Figure 9). In the top right corner, by clicking on the user's name, they can access their profile (Figure 10) and edit the desired information (Figure 11).

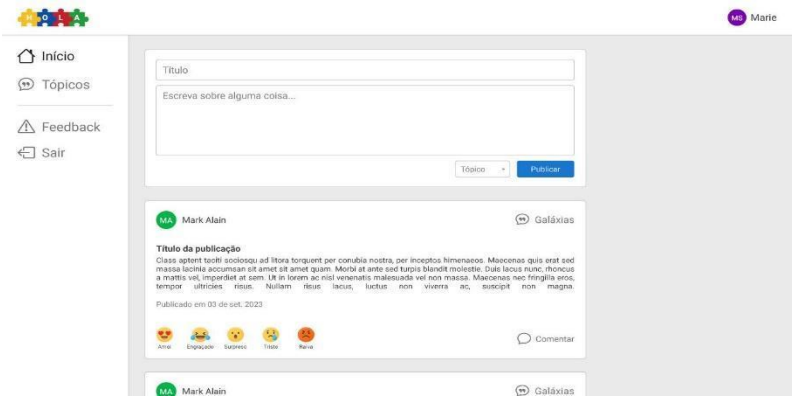

Figure 7: Timeline: Hola (Social Network Name) / Marie (User Name) / Home / Topics / Feedback / Log out / Title / Write about something / Topic / Publish / Mark Alain (Another user) / Galaxies / Post title / Lorem ipsum / Published on Sep 3, 2023 / Loved it / Funny / Surprised / Sad / Angry / Comment. Source: Authors.

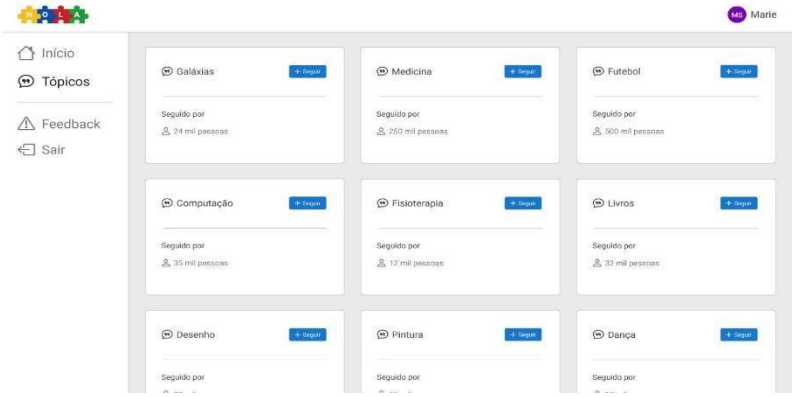

Figure 8: Topics (Listing): Hola (Social Network Name) / Marie (User Name) / Home / Topics / Feedback / Log out / Galaxies / Medicine/ Soccer / Computing / Physical therapy / Books / Drawing / Painting / Dance / Follow / Followed by X people. Source: Authors.

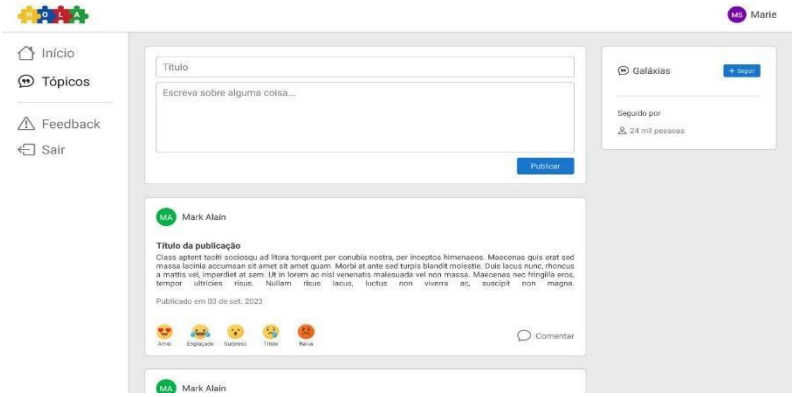

Figure 9: Topics (Specific): Hola (Social Network Name) / Marie (User Name) / Home / Topics / Feedback / Log out / Title / Write about something / Publish / Galaxies / Follow / Followed by 24,000 people / Mark Alain (Another user) / Post title / Lorem ipsum / Published on Sep 3, 2023 / Loved it / Funny / Surprised / Sad / Angry / Comment. Source: Authors.

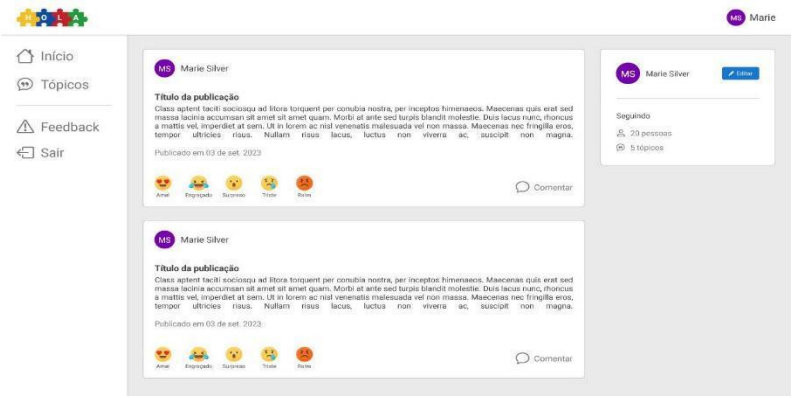

Figure 10: User Profile: Hola (Social Network Name) / Marie (User Name) / Home / Topics / Feedback / Logout / Marie Silver (User full name) / Post title / Lorem ipsum / Published on Sep 3, 2023 / Loved it / Funny / Surprised / Sad / Angry / Comment / Marie Silver / Edit / Following 20 people / Following 5 topics. Source: Authors.

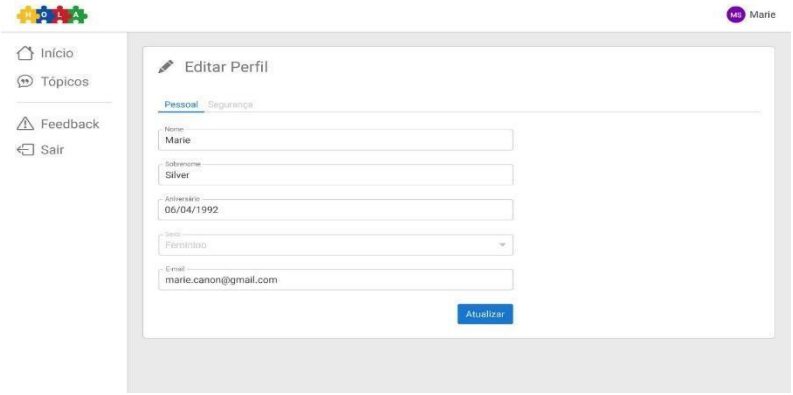

Figure 11: Edit Profile: Hola (Social Network Name) / Marie (User Name) / Home / Topics / Feedback / Logout / Edit profile / Personal / Security / Name: Marie / Lastname: Silver / Birthday: 04/06/1992 / Gender: Female / Email: marie.canon@gmail.com / Update. Source: Authors.

When viewing another user's post, it's possible to click on the person's name and enter their profile (Figure 12). Finally, from the side menu, you can click on the feedback button and be directed to the feedback page (Figure 13), where you can leave a comment about the user's experience using the social network.

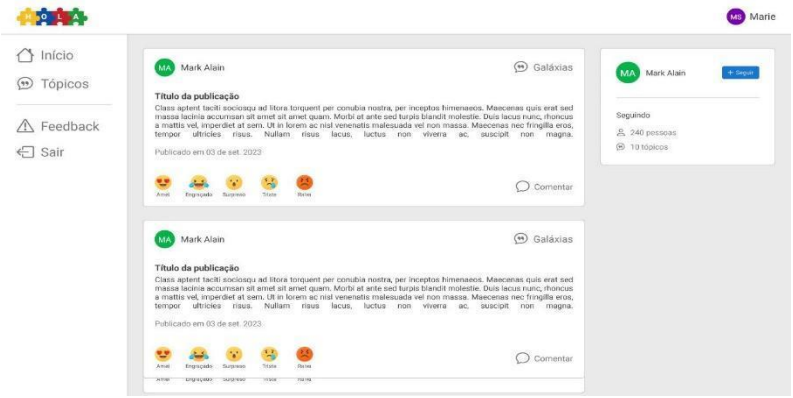

Figure 12: Another User's Profile: Hola (Social Network Name) / Marie (User Name) / Home / Topics / Feedback / Logout / Mark Alain (Another user full name) / Galaxies / Post title / Lorem ipsum / Published on Sep 3, 2023 / Loved it / Funny / Surprised / Sad / Angry / Comment / Mark Alain / Follow / Following 240 people / Following 10 topics. Source: Authors.

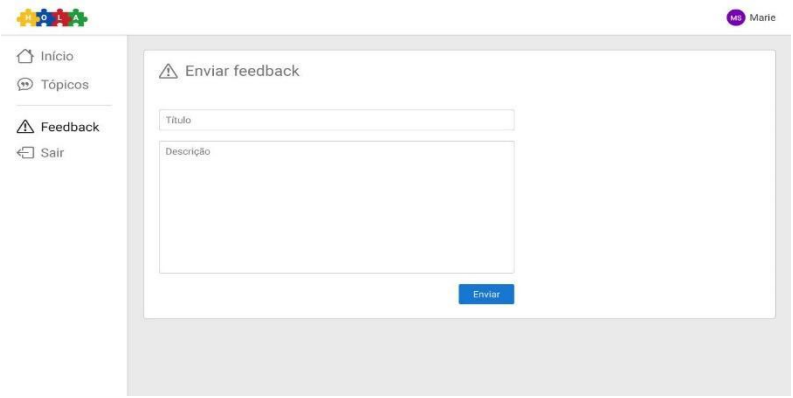

Figure 13: Send Feedback: Hola (Social Network Name) / Marie (User Name) / Home / Topics / Feedback / Logout / Send feedback / Title / Description / Send. Source: Authors.

4 Evaluation

The usability and accessibility evaluation was conducted through four different evaluation perspectives. First, initial usability tests were carried out within the scope of the HCI course, using System Usability Scale (SUS). After the course ended, three additional evaluations were conducted: a heuristic evaluation by four usability experts using Nielsen's heuristics [31]; tests with automated tools to assess usability and accessibility; and finally, a content evaluation with an ASD specialist. These evaluations are described below.

4.1 Initial Usability Tests

After completing the application, usability tests were conducted. For this purpose, a script with specific tasks was prepared and executed by the user, such as: searching for a specific topic, creating a theme, liking a post. In this test, there was a moderator who requested the execution of the task, an observer who noted the difficulties that users encountered, and someone recording the test.
Then, a form based on the System Usability Scale (SUS) instrument (Table 3) [37] was sent, with statements to be answered according to the *Likert* scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to understand the usability testing experience of the social network.
For this test, only three responses were collected. The users' profiles were two Computer Science students and one usability expert. Table 3 presents the questions and answers of the three users, while Figure 14 shows the related graph.

Table 3: Form based on the System Usability Scale (SUS). Source: Authors.

Number	***Question***	***User 1***	***User 2***	***User 3***
1	I think I would like to use this social network frequently.	4	5	5
2	I find the social network unnecessarily complex.	1	1	2
3	I found the social network easy to use.	5	5	4
4	I think I would need help from a person with technical knowledge to use the social network.	1	1	1
5	I think the various functions of the social network are very well integrated.	5	5	5
6	I think the social network shows a lot of inconsistency	2	1	1
7	I imagine that people will learn how to use the social network quickly.	5	5	5
8	I found the social network confusing to use.	1	1	1
9	I felt confident using the social network.	5	5	5
10	I had to learn several new things before being able to use the social network.	1	1	1

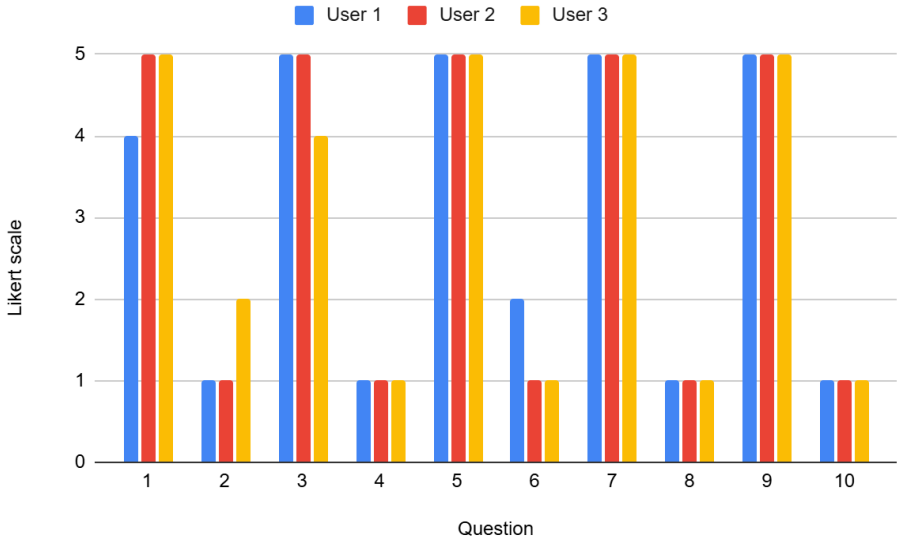

Figure 14: Form answers. Source: Authors.

Indeed, the sample size of individuals is insufficient to draw any conclusion, but it was valuable for the learning process of the students (development team) to understand how to conduct a usability test.
Based on the methodology established by the SUS, the calculated score for this application was 96.67, which falls within the best evaluation range for an application according to the SUS (92 to 100 points), signifying "best imaginable." Thus, for this small group of users, it was evident that there was excellent acceptance among the respondents, with 100% of them believing that they do not need technical knowledge to use it, that the functions are very well integrated, and that people will learn how to use it quickly.

4.2 Heuristic Evaluation

Heuristic evaluation is an indirect method of usability assessment that allows for the identification of various problems in system interfaces. It consists of a set of ten general rules (heuristics). These ten fundamental usability principles developed by Nielsen provide a foundation for evaluating software products, originally aimed at web applications. These principles include: Visibility of System Status; Match Between the System and the Real World; User Control and Freedom; Consistency and Standards; Error Prevention; Recognition Rather than Recall; Flexibility and Efficiency of Use; Aesthetic and Minimalist Design; Help Users Recognize, Diagnose, and Recover from Errors; Help and Documentation [38].
To conduct the heuristic evaluation, three HCI specialists with over 10 years of experience were invited. Initially, each evaluator navigated through the program's interface until they encountered a usability problem. Once a problem was identified, it was categorised according to the proposed heuristics. For example, if the evaluator could not locate a help tool within the program, they would categorise this issue accordingly. Each evaluator completed this step at least three times.
All identified problems were recorded in a table, and a severity rating was assigned, ranging from 0 to 4, based on the evaluator's judgement: 0 for issues of no importance; 1 for cosmetic problems that do not require correction unless extra time is available; 2 for minor issues; 3 for serious problems; and 4 for catastrophic issues. Additionally, the context and possible cause of each problem were noted, providing valuable information for analysing the failure and identifying ways to correct it.

As a result of the heuristic evaluation, 18 issues were identified in the interface of the Hola Social Network. The distribution and classification of these issues are discussed below. Eight issues were classified under the "Error Prevention" heuristic, with six considered severe and two classified as minor. These problems generally relate to content publication: the system sends a message indicating that the content could not be posted, but it is actually

posted, leading the user to repost it, resulting in content duplication. Additionally, the system does not allow posting content in a topic that is not followed, but the content still appears in the user's list.
The second heuristic with the most identified issues is "Visibility of System Status," with three minor problems. These issues pertain to the system's feedback on ongoing processes when it becomes slow, the lack of updates to the follower count on a topic, and the newly published content not being visible unless the user attempts to comment on it again.
Regarding the "User Control and Freedom" heuristic, three issues were identified, with two being severe and one minor. These problems include the lack of an option to insert an image with a post, the maximum character limit being considered too small, and difficulty finding how to insert a new topic. Concerning the "Help and Documentation" heuristic, a severe error was identified due to the absence (or lack of identification) of a help system. Under the "Consistency and Standards" heuristic, a minor error was identified, where the system displays "Following 1 person," but it is not possible to see who the user is following, which would be expected in a system of this nature. Lastly, under the "Recognition rather than Recall" heuristic, an issue was detected regarding the "Feedback" function, as it was unclear whether it referred to the system or a specific topic.

4.3 Automatized Tests

To conduct the automated accessibility tests, the Axe Core tool for React was used, which allows for the identification of accessibility issues in real-time. The tool automatically scans components and pages, providing detailed reports on potential barriers that may hinder usability, ensuring that the applications comply with accessibility guidelines such as the WCAG (Web Content Accessibility Guidelines).
The accessibility errors found were divided into three categories: serious, critical, and moderate. Regarding the serious errors, two issues were observed: the insufficient colour contrast, meaning the elements do not meet the minimum colour contrast criteria, which makes text difficult to read for people with visual impairments; and some links on the site lack discernible text, meaning screen readers will not know where the link will lead. To address these errors, it is necessary to adjust the text and background colours to ensure adequate contrast and ensure that all links contain descriptive text indicating the function of each link.
In the case of the critical error, only one was found: the lack of alternative text for images, which prevents screen readers from describing the image to users with visual impairments. To address this, it is important to add descriptive "alt" attributes to the images to provide context for users who cannot see the images.
Finally, three moderate errors were found: the lack of a primary navigation landmark, meaning the site should contain at least one navigation landmark, such as "main," to assist users who use assistive technologies; the absence of a level one header (<h1>) to structure the content hierarchically, which makes navigation more difficult for users who need assistive technologies; page content outside landmarks, meaning that all page content should be contained within navigation landmarks, such as <header> and <footer>, to improve navigation and accessibility.

4.4 Contents Evaluation

For the content evaluation, a professional in the field of speech therapy was invited. Initially, an explanation was provided about the concept, functionality, and purpose of the social network. Following this, the professional navigated through the program's interface, observing its functionality and accessibility.
Afterward, the accessibility specialist reported through a form and a meeting that the social network could engage adolescents and adults with ASD, as it is easy to use, intuitive, and has an appropriate design. The accessibility features for these individuals are adequate, but additional features could be added to further facilitate the use of the network. For example, specifying during account creation that the last name should be entered and providing the character limit for the password would help reduce difficulties in decision-making.
Additionally, it is possible to offer a report on the network usage over a specific period, informing the user about the time they spent on a particular topic, entering information, and interacting. This could help increase the diversity of topics and improve interpersonal activities. A similar report can also be made available to professionals as a therapeutic tool, complementing therapy sessions. It would contain information that helps improve social communication, which is particularly challenging for individuals with ASD, by observing how the person structures their interaction.

5 Conclusions

This article presented the development and evaluation of a social network designed for individuals with Autism Spectrum Disorder (ASD), aiming to promote interaction and socialization among users. Through a detailed analysis

of the specific needs of individuals with ASD, the project incorporated accessibility and usability concepts to create an adapted platform, emphasizing simplicity in the interface and content organization to facilitate communication.

The main contributions of this work include the creation of an accessible digital environment and the implementation of strategies to improve the social skills of individuals with ASD. The social network "Hola" was designed to provide a safe and engaging space for adolescents and young adults with ASD, facilitating the exchange of ideas around topics of common interest. Usability testing and consultation with specialists provided valuable feedback, allowing for adjustments that improved the platform's quality.

In view of the specific needs of individuals with autism, the social network encompassed not only accessibility features but also strategies to encourage the social development of these individuals. With that being said, the introduction of interest topics was emphasised to offer a specific and familiar context to the individual, facilitating the initiation of social interaction. Similarly, the thoughtful arrangement of content on the timeline was highlighted to enhance the interpretation and communication of individuals with autism regarding the information.

While this work makes significant contributions, it is important to acknowledge limitations that may have influenced the results and their interpretation. One notable limitation is the absence of a responsive design, which restricts access for users on mobile devices. This limitation reduces the platform's reach and may have impacted the representativeness of the findings, as users in dynamic contexts might have faced challenges accessing the social network. Additionally, the evaluations were conducted with experts and students, but not with the intended target audience—individuals with Autism Spectrum Disorder (ASD). This exclusion affects the external validity of the study, as the responses gathered may not accurately reflect the real-world experiences of adolescents and young adults with ASD. The lack of approval from the Ethics Committee for testing with the target audience further constrained the depth of usability and accessibility evaluations.

The restricted time frame of four months for the project's development and evaluation posed another challenge. This limited the opportunity to incorporate additional features and conduct more extensive testing, potentially resulting in some aspects of the interface, such as the identification of subtler issues, receiving less refinement. Furthermore, the small and homogeneous sample size used for usability testing restricts the generalizability of the results. Although the high score achieved on the System Usability Scale (SUS) suggests positive reception, the narrow participant pool could have introduced bias into the findings.

Another limitation lies in the absence of advanced features, such as gamification elements, private chat options, and personalized reports for therapeutic use. These features could have enhanced the platform's clinical and educational utility by further fostering social skills and communication. Consequently, the results of this study should be interpreted with caution, as the lack of robust data from the target audience leaves some practical aspects of the system's interaction unverified.

Despite these challenges, the identified limitations offer valuable directions for future work. Subsequent studies should prioritize testing with end-users, enhancing the platform's compatibility with mobile devices, and introducing gamification and other engaging features. Expanding the diversity of test samples would also strengthen the validation of results and better reflect the needs of the intended audience.

This reflection on limitations underscores the study's commitment to transparency and the continuous improvement of technological solutions aimed at the social inclusion of individuals with ASD. It is hoped that these insights will contribute to the development of a more robust and impactful platform in the future.

Regarding future work, some adjustments could be made and additional features added. Thus, it would be necessary to add responsiveness to facilitate access through mobile devices. It would also be important to conduct usability tests with the target audience. Additionally, some functionalities could be included: a chat for sending private messages; an option to mark events in a specific topic of interest; and gamification features to stimulate interaction among users, boosting the development of social skills.

Therefore, it is hoped that the project can proceed to a new stage in order to be improved. Future work could focus on conducting tests with real users, adding new features such as private chat, event marking, and gamification, as well as adapting the platform for use on mobile devices. It is hoped that the "Hola" social network can evolve into a robust tool that not only promotes communication among people with ASD but also assists health professionals in monitoring the social development of patients over time. Finally, this work represents a part of academic commitment in the search for solutions to assist individuals with autism in the development of social skills.

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