Following UCD and SCRUM for Designing a Virtual Environment to Support the Emotional Development of Children with Autism

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Abstract

This research focuses on developing an innovative virtual reality application designed to support the emotional development of children with autism. The main objective is to create a design that effectively addresses the needs and expectations of these children by incorporating features that reduce frustration and optimize usability. In this work, we used user-centered design (UCD) throughout the development process to ensure that the emotional and cognitive needs of the users were understood and integrated into the application's design. This allowed us to incorporate feedback from parents, therapists, and children to create a more intuitive virtual reality experience. We also used SCRUM to manage the iterative development process. Combining these methodologies creates a virtual environment that potentially minimizes stress, promotes emotional development, and provides a better user experience.

Keywords

Supportive Technology, User-Centered design, Interactive learning tools, Educational games, Gamification for autism.

1   Introduction

Emotions are essential to human development, influencing how individuals interact with their environment and others [11]. For individuals with autism, managing and expressing emotions presents unique challenges, as autism is a neurodevelopmental disorder characterized by difficulties in social communication and often a deficit in recognizing and expressing emotions [11]. These difficulties may manifest in various ways, such as an inability to interpret others' emotional cues, limited or inappropriate emotional expression, and problems regulating their own emotions in everyday situations.

Limitations in emotional management can have significant consequences for individuals with autism, affecting their ability to interact and handle situations that require emotional responses socially. The lack of understanding and expression of emotions can lead to frustration, isolation, and misunderstandings in their interpersonal relationships. Therefore, it is crucial to intervene early to develop their emotional skills, starting with a basic understanding of emotions and progressing toward appropriate and effective expression [7].

The process of teaching emotional skills to individuals with autism often involves the use of specific resources designed to enhance emotional understanding and communication [4]. Social stories accompanied by images, pictograms, narratives, and other educational materials have proven helpful in this context. These tools help break down complex emotional situations into more straightforward, manageable elements, thus facilitating their understanding and practice of appropriate emotional responses [14].

In recent years, the incorporation of technology has opened new possibilities for supporting emotional development in individuals with autism [6]. Devices such as tablets, computers, and mobile phones have created interactive and personalized environments that facilitate emotional learning. Furthermore, emerging technologies like augmented reality (AR) and virtual reality (VR) have shown great potential to revolutionize this field.

VR, in particular, offers an immersive experience that can simulate real-life situations in a controlled and safe environment. Through virtual reality, users can practice interpreting emotional cues and expressing emotions in a realistic context [7]. This technology allows individuals with autism to rehearse social interactions, learn to manage emotional situations and develop skills that are difficult to acquire in traditional teaching settings. As a complement to other intervention methods, virtual reality can be a powerful tool in the emotional development of individuals with autism.

2   Objective

This research aims to design a virtual reality experience to support the emotional development of children with autism. This design seeks to integrate functionalities and features tailored to the specific

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needs of these children to provide an immersive experience that minimizes stress and fosters emotional growth. The proposal focuses on creating a virtual environment that is accessible and safe, thereby helping to enhance the emotional well-being of the users.

3   Background

Autism, a developmental disorder often identified in the early years of life, requires early intervention to maximize its effectiveness [1]. Starting therapeutic processes as soon as possible allows children with autism to develop social, communication, and adaptive skills more robustly, which enhances their quality of life and facilitates their integration into various contexts [14].

Therapies aimed at children with autism include activities designed to promote emotional development, beginning with emotion recognition. In this context, play-based approaches are especially valuable as they allow for safe and creative exploration and expression of emotions. Cognitive-behavioral therapy sessions also play an important role in teaching children strategies to handle stressful situations and improve their social skills [8].

As research progresses, therapeutic activities are adjusted to better meet each child's needs. Flexibility in therapeutic methodologies allows for greater customization and, therefore, more effective treatments [9]. Technology, especially virtual reality (VR), has introduced new possibilities in therapeutic intervention. VR offers advantages such as simulating social situations in a controlled environment, which allows for managing sensory stimuli during activities [10]. However, virtual reality also presents challenges, such as the risk of dependence, overstimulation, or dizziness. Therefore, it is crucial to use it in a balanced manner with short sessions to minimize negative effects [9].

Technology development for individuals with autism must deeply consider their specific needs and challenges. Given the broad spectrum of autism, skills and difficulties vary significantly among individuals [12]. It is essential to address sensory sensitivity, whether hypersensitivity or hyposensitivity to stimuli such as sounds or textures. To avoid sensory overload, technology should feature intuitive interfaces and provide clear instructions adapted to the capabilities of the target group [13].

Recently, a trend has emerged in the field of human-computer interaction (HCI), which is focused on detecting users' emotions during activities. An example of this trend is the EmoTEA application, which uses facial expression detection as part of the game to monitor the emotions of children with autism [7].

Another relevant study is the 3CFER mobile learning system, which uses a humanoid 3D character to present situations and explain the events and possible emotions they generate. The results of this study have been positive, showing outstanding performance in emotional development [4].

Similarly, in research on cognitive attention in autism using VR learning tools, a VR platform is being developed for individuals with autism) who face difficulties in social interactions, communication, and emotional recognition. This study highlights that virtual reality offers a safe environment where children can practice and learn without social fear. EEG signals are used to assess functional connectivity while children learn with educational cards. Findings suggest that virtual reality can enhance cognitive abilities in children with autism [2].

4   Approach and research methods

The present study aims to design and develop a virtual reality (VR) application specifically oriented toward improving the aspects competencies of children with autism. To achieve this goal, a user-centered approach it adopts, meaning that special attention will be given to the needs and preferences of the end users throughout the entire design and development process. This approach is also supported by the participatory design methodology, which actively involves users and other stakeholders in the design process. In this way, the aim is to ensure that the application adequately responds to the specific emotional needs of children with autism and that the designed functionalities are effective and useful in their therapeutic context.
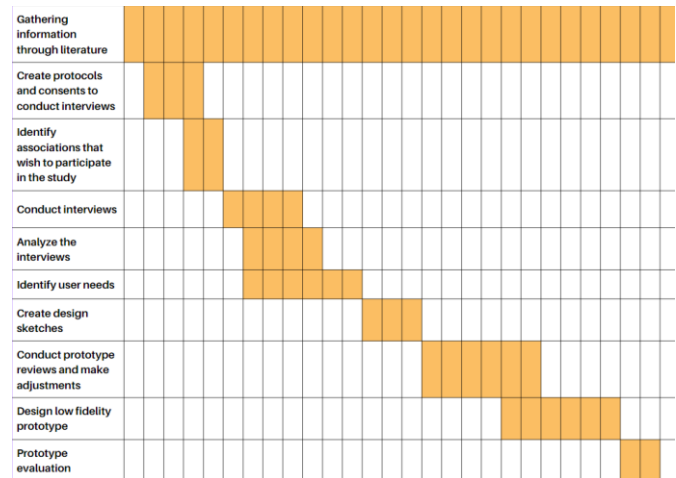
4.1   Research Methods

Figure 1. Gantt chart for better organization of the activities required to design the virtual reality environment

The design process will be structured and organized through a Gantt chart (see Figure 1), which outlines the timeline and phases of the activities required to create the virtual reality environment. This chart is crucial for ensuring that the project stays on track, with clear deadlines for each phase of the research, design and development process.

4.1.1   Exploratory Research:

To gather information about the needs of the target users (children with autism), interviews were conducted with parents or guardians and therapists knowledgeable on the subject. Semi-structured interviews were designed to gather additional information not covered in the initial research. To conduct these interviews, information was first collected through previous literature on autism studies and the use of technology with children with autism. Additionally, a protocol for the interviews was created. To develop it, the information being sought was analyzed. In this case, the main goal was to understand the acceptance of technology by children with autism and their parents, along with the therapists' recommendations. Information that could assist in designing the project was also sought, such as components that capture the attention of children with autism in technology or in their daily lives.

Then, the target audience for the interviews was selected, including parents and therapists. A script was designed to maintain the order of the questions and estimate the approximate time needed to complete them. With the script ready, the next step was to choose when and where the interviews would take place. This also required gathering equipment such as audio recorders, pens, and paper. Furthermore, an informed consent form was created to explain the purpose of the interview, how the data would be used, and to ensure the confidentiality of the obtained data.

During the interviews, the data was recorded using audio devices to ensure accuracy and completeness. After the interviews, the recordings were transcribed to create a detailed written record of each session. The data was then analyzed by identifying key themes, patterns, and perspectives that emerged from the interviews. This analysis helped to understand the views of parents, guardians, and therapists and guided the design process by highlighting important considerations for the target users. Finally, the findings from the data analysis were compiled into a report, which was used to guide the prototype development.

4.1.2 Participants Design

An essential part of the process will be the organization of co-design workshops in which therapists, virtual reality experts, and the children's guardians will participate. These workshops will allow the co-creation of the application's features and functionalities, ensuring that every design aspect is aligned with the user's needs and expectations. User-centered design will be used to guide this process, with feedback from these workshops playing a crucial role in shaping the design to meet the emotional and cognitive needs of the children. Another important part of this project is the interviews that will be conducted with parents, tutors, and therapists to gather more information. These interviews will provide deeper insights into the specific needs of children with autism and their caregivers, contributing to refining the application.

Prototyping

With the insights gained from the workshops, initial prototypes of the application will be developed. These prototypes will be evaluated through expert feedback to identify improvements before moving on to later stages of development. This part of the project will follow the SCRUM framework [11], allowing an iterative development process.

Design Feedback

Once the design proposals have been developed, they will be presented and explained to the therapists and guardians involved in the project. Their opinions and suggestions for possible improvements and changes will be sought to select the design that best meets the identified needs. After incorporating the feedback, the selected design will undergo an evaluation phase, where it will be tested with a small group of users to assess its effectiveness, usability, and overall alignment with the project's goals. This evaluation will help ensure that the final design not only meets the expectations of therapists and guardians but also effectively addresses the needs of children with autism.

4.1.3 Ethical Considerations

Informed Consent

It is essential that all participants and their guardians clearly understand the purpose of the research. Before participating, they will be asked for their informed consent, guaranteeing them the right to withdraw from the study at any time if they so wish, without any negative consequences.

Information Security

The confidentiality and security of the data obtained during the interviews will be a priority. All collected information will be stored in a secure location, protected by a password, and personal data will be anonymized to protect the participants' privacy. In this way, sensitive information will be ensured to be handled ethically and securely.

5 Next Steps

The literature review suggests that VR can offer a controlled and safe environment where children with autism can practice recognizing and expressing emotions without fearing social judgment. Previous studies have shown that VR applications can effectively simulate social situations, allowing children to face emotional scenarios gradually and personally. Additionally, the ability to adjust sensory stimuli in VR is highlighted, which is crucial given that many children with autism experience sensory hypersensitivity or hyposensitivity.

The SCRUM methodology has been fundamental in managing the iterative development process. It has allowed the team to respond quickly to changes and continually refine prototypes based on feedback. SCRUM will remain essential for development, as each iteration will incorporate new findings from user testing and expert consultations, ensuring the product evolves in line with the user's needs. On the other hand, User-Centered Design has been vital in maintaining a focus on the specific needs of the children with autism. This ensures that every feature is tested and validated with end-users, helping to create an intuitive and user-friendly interface. This approach will continue to guide future design decisions, ensuring that the VR environment is both safe and supportive for the children.

However, the findings also indicate that the use of VR is not without risks. There is concern that prolonged use could lead to overstimulation, dependency, or even dizziness in some children. Moreover, the effectiveness of VR can vary significantly depending on the individual characteristics of each child, underscoring the need for a highly personalized design. Another identified challenge is the need for intuitive and user-friendly interfaces specifically designed for children with communication and comprehension difficulties.

The needs analysis and consultation with experts and therapists have emphasized the importance of a participatory design approach. The results suggest that involving end users, including both the children and their caregivers and therapists, is crucial for developing a tool that is both useful and safe. Since this study is in the conceptual design phase, the need to iterate on the design process, adjusting the application to the specific emotional and sensory needs of each child, has been emphasized.

The initial data found after conducting the interviews suggests that a well-designed VR application could have a positive impact on the emotional development of children with autism. However, it is necessary to continue refining the design to maximize its effectiveness. In conclusion, while the preliminary results are promising, a careful and personalized approach is required in the design and use of VR in emotional therapies for children with autism. Future research should focus on the continuous evaluation

and adaptation of this design to ensure safety and that the functionalities meet the users' needs.

6 Acknowledgments

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