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Interactive technology to support therapeutic interventions for emotional regulation of people with intellectual disabilities

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Abstract
People with intellectual disabilities might experience difficulties in recognizing emotions, problems in understanding the causes and consequences of emotions, and problems with self-control, inhibition, and emotional regulation. Emotional regulation represents a significant hallmark of cognitive development and an important achievement associated with social, behavioral, and academic competence; therefore, people with intellectual disabilities need to learn how to regulate their emotions appropriately. An approach to support the emotional regulation interventions of this population is interactive technology such as video games, interactive floors, and virtual reality. The literature includes some works on the design, development, and evaluation of technology for emotional regulation for populations that share some characteristics with people with intellectual disabilities, such as ASD and ADHD; however, the design of this technology does not consider some characteristics of people with intellectual disabilities. In this research, we propose to develop a model based on a set of technologies to support therapeutic interventions of emotional regulation of people with intellectual disabilities.

Keywords:
Intellectual disabilities; Interactive technology; Emotional regulation.

1 Introduction and Motivation
Intellectual disability is a disorder that begins during the developmental period; it includes limitations of intellectual functioning and adaptive behavior [1]. Intellectual disability is usually identified before the age of 18 years old. The Diagnostic and Statistical Manual of Mental Disorders, 5th Edition of the American Psychiatric Association (DSM-5), stipulates that intellectual disability presents various conceptual, social, and practical limitations [1]. Among the main characteristics of people with intellectual disabilities are delayed acquisition of speech and self-care skills, reduced vocabulary, short attention spans, limited initiative, delayed cognitive acquisitions, deficits in academic learning, and emotional and social maladjustment [1,4]. Specifically, among the emotional characteristics of this population, we can highlight that they experience the same emotions that neurotypical people, they present difficulty in recognizing emotions, as well as in naming some of them, they have problems in understanding the causes and consequences of emotions and difficulties with self-control, self-motivation, inhibition, and emotional regulation [4,5]. Emotional regulation is essential in cognitive development and a significant achievement associated with social, behavioral, and academic competence.[6,7]; therefore, people with intellectual disabilities need to learn how to regulate their emotions appropriately.

There are several interventions to promote emotional regulation, they can be performed at home, in the school environment, and some others are therapeutic. Examples of therapeutic interventions are the SCERTS and JASPER Model's [2,3], mindfulness and dance movement therapy [2,16]; the latter two reported to have positive effects on stress management and improvement of different emotional aspects in people with intellectual disabilities. However, there are still challenges in using these interventions in special education, such as maintaining the participants' attention, the lack of interactivity of the materials, and the fact that each special education teacher or psychotherapist must adapt the materials to the characteristics of each individual [17].

An alternative to enhance emotional regulation interventions is interactive technology, such as video games, interactive floors, and virtual reality. Several studies have shown how technology can support several skills of people with intellectual disabilities. For example, STOMP [13] is based on an interactive floor that allows users to interact with digital environments by activating pressure sensors embedded in a carpet. This system demonstrated that people with intellectual disabilities could physically participate in various problem-solving and challenge overcoming activities using this technology. On the other hand, VirtualMath [14] is a serious virtual reality game designed to support the teaching of logical-mathematical concepts to students with intellectual disabilities. VirtualMath was evaluated with students with intellectual disabilities, and the results indicate that it contributes to the development of mathematical reasoning in this population. These works show evidence that interactive technology supports the

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development of several skills of people with intellectual disabilities.

2 Related Work

The literature reports some technological systems that support emotional regulation in different populations with disabilities, such as autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), and developmental disabilities. These works use technologies such as wearable devices, mobile devices, relaxation rooms, and virtual reality. In addition, most of these works are in the evaluation stage.

Within the body of work developed to support emotional regulation, we found that most of them are aimed at people with ASD and include an evaluation. For example, the work of Torrado, J.C., & Gomez, J. (2017) uses wearable computing to support the teaching of coping strategies in children with ASD for supporting their emotional self-regulation. The system measures the user's heart rate using a smartwatch to detect emotional changes; once the signal exceeds a certain threshold, established as a basis for detecting stress for each user, the device vibrates and shows the user a coping strategy using pictograms. The coping strategies used in the application were defined, taking into account the information provided by an expert in psychopedagogy. These strategies are the following:

- Counting a sequence of numbers.
- Sitting down and relaxing.
- Searching for a particular object.
- Going for a walk.
- Asking an adult for help.
- Breathing exercises.
- Asking for a hug.
- Watching funny or relaxing images.

This technology was evaluated in a classroom setting with two children with ASD for nine days. Individuals were followed for three days beforehand to obtain a heart rate threshold to detect stress in each participant (baseline). Their caregivers kept a record of their stress episodes, including episodes of outbursts or anger. The results of this assessment indicate that participants were able to control most of their stress episodes in less time than baseline. However, a more extensive evaluation with more participants is needed to know whether the results are sustained in the long term and whether this technology supports participants in improving their stress episodes.

On the other hand, within the category of mobile devices, we found the work of Fage, C. (2015), which explores the use of this technology to support the teaching of coping strategies in the process of emotional self-regulation of children with ASD within the classroom. The technology uses the "Regulation Zones" strategy. This strategy questions the user about the emotion they are having at a specific moment and its intensity or level, showing the user how they can regulate their emotions, if necessary, by providing regulation strategies associated with that intensity. To define the strategies used in the application, they used participatory design sessions with families, special education teachers, and therapists. The strategies implemented are listed below:

- Breathing management.
- Visualization of relaxing images.
- Parent-guided co-regulation.
- Withdrawal to a quiet area for a set period.

The authors evaluated the application's usability and efficacy as an emotional coping application in school classrooms with ten participants: five children with ASD and five neurotypical children. The evaluation lasted three months. The results showed that the application was easy to use and provided relevant support for the emotional self-regulation of children with ASD within the classroom.

The work of Carlier, S., et al. (2019), also developed for mobile devices, aims to investigate the use of serious video games to reduce stress and anxiety in children with ASD. An on-the-shelf game was taken as a base and was modified based on the characteristics of this population. In addition, they developed an extra relaxation module, using breathing techniques and visualizations of relaxing images. Multisensory environments inspire the game environment to stimulate the user and lower their stress levels. They evaluated the game with three children with ASD for two weeks. The results indicate that the game requires design modifications and an evaluation with a higher number of participants to determine if it supports the reduction of stress and anxiety levels in children with ASD.

Another population for which technology is being developed to support their emotional regulation process is people with ADHD. Within this category is "CoolCraig" [11], a work in the development stage, which aims to explore how the use of smartwatches can support the process of emotional co-regulation and self-regulation in children with ADHD. CoolCraig uses the "Regulation Zones" strategy to identify the user's emotional state and the token economy strategy to assign the goals to be achieved by the user and thus obtain rewards. Also, it implements a mobile application used by caregivers. On the smartwatch screen, the user's goals are indicated, and the time is set when the application will show the user the coping strategy to follow. Finally, it keeps a history of the goals and rewards achieved by the user and the regulation zones they had during the day. Although this work shows how the design of CoolCraig considers the characteristics of people with ADHD, it still needs to be implemented and evaluated to investigate its effectiveness in supporting emotional regulation in people with ADHD.

The work of Zheng, H. & Motti, V.G (2017) is aimed at developmental disabilities. In this sense, the literature indicates that ASD, ADHD, and intellectual disability are grouped within developmental disability [1]. This research explores how smartwatches can support emotional self-regulation in individuals with developmental disabilities within the classroom. They also created a smartphone application, where the student's caregiver can send notifications to give the student cues about their behavior in class. When the notification arrives, the smartwatch vibrates and displays the caregiver's indication on the screen using pictograms and text. The caregiver can send four types of notifications:

- Prompts: Used to support the user to moderate his behavior inside the classroom, notifying him to concentrate, keep quiet or participate.
- Self-regulation: The caregiver can send a notification to request that the user reports his emotional state, using the "Regulation Zones" strategy.
- Checklist and survey: To support the user to be prepared to take their classes, the system allows sending a list of materials that the user should have ready, and the user can also give feedback on the class.
- Countdown, alarm, and settings: Allows caregivers to set notifications to the user about how long they should be doing an activity or notice that it is time to return to class.

The authors evaluated their technology with five students with developmental disabilities. The results indicated that the assistance provided should be customized for each student and the application context. In addition, the app should be able to offer two modalities, one offering more functions to intervene and improve students'

performance in class, and another dedicated to functions such as positive reinforcement or self-regulation to encourage students to be more independent.

These works leave us with some open challenges regarding the technologies used in other emotional competencies and with different populations and the opportunity to use them for emotional regulation and people with intellectual disabilities.

3 Description of the Research

Emotional regulation is associated with the social, behavioral, and academic competence of people with intellectual disabilities; this is important for them to achieve an independent life [6,7].

Several studies indicate that technology can support the development of different skills, such as problem-solving and the teaching of logical-mathematical concepts, in this population [13,14]. The literature includes works on the design, development, and evaluation of technology for emotional regulation for populations that share some characteristics with people with intellectual disabilities, such as ASD and ADHD; however, the design of this technology does not consider some characteristics of this population.

In general, the works we found in the literature that supports emotional regulation are designed to be used within the classroom setting. We did not find any technological applications that demonstrate their effectiveness during therapeutic interventions for emotional regulation of people with intellectual disabilities.

3.1 Research Questions

The main research question that guides this research is:

How can therapeutic interventions for emotional regulation of people with intellectual disabilities be supported using technologies appropriate for this population?

3.2 General Research Objective

Based on the areas of opportunity detected above, we propose the following general research objective:

To develop a model based on a set of technologies to support therapeutic interventions of emotional regulation for people with intellectual disabilities through the design, implementation, and evaluation of prototypes based on a contextual study that includes the review of technologies applied to special education.

3.3 Methodology

To answer the main research question and address the general objective stated above, we propose to use the Design Thinking methodology [15], which is an iterative user-centered design methodology, which consists of five stages as detailed below:

Empathize: In this stage, we will conduct a contextual study in several clinical centers that provide therapeutic interventions to people with disabilities. We will interview experts, such as therapists, psychologists, and teachers, who work with people with intellectual disabilities. Observation sessions will be carried out during the therapeutic sessions of emotional regulation to learn about the activities carried out and the strategies used to analyze how they can be supported using technology. In addition, we will conduct sessions with people with intellectual disabilities where we will test different technologies to learn which of its features are suitable for the population's needs.

Define: In this stage, we will analyze the data obtained in the previous stage to identify the characteristics and interaction models that technology should have to adapt to people with intellectual disabilities. We will translate the characteristics obtained into possible scenarios of use, showing how technology can support therapeutic interventions to favor the development of emotional regulation. Subsequently, we will validate these scenarios with therapists, psychologists, and teachers working with people with intellectual disabilities.

Ideate: Once the characteristics of the scenarios have been defined, we will carry out participatory design sessions with therapists, psychologists, teachers, people with intellectual disabilities, and experts in Human-Computer Interaction to obtain a set of design features, which the model should have for the support of therapeutic interventions for emotional regulation of people with intellectual disabilities.

Prototype: Based on the design features defined above, we will create low and medium-fidelity prototypes of the model based on a set of technologies to support emotional regulation in therapeutic interventions for people with intellectual disabilities. We will validate these prototypes with experts, and subsequently, a high-fidelity prototype will be developed.

Evaluate: In this stage, we will evaluate the low and high-fidelity prototypes of the model through a set of formative evaluations to analyze the user experience and the interaction model. Subsequently, we will conduct summative evaluations to analyze the model's effectiveness in supporting therapeutic interventions of emotional regulation of people with intellectual disabilities.

4 Current State of the Research

We started the contextual study, and currently, we are conducting semi-structured interviews with special education teachers and psychologists working in centers that provide educational and therapeutic interventions to people with special needs. We have also conducted observation sessions during different therapies involving people with intellectual disabilities. We are analyzing the collected data using grounded theory techniques and affinity diagrams. By the end of this year, we expect to have the first low-fidelity prototypes of the technology.

5 Required Feedback

I am interested in receiving feedback on the criteria for delimiting the characteristics of the population and on the methods for evaluating the model's effectiveness in supporting the emotional regulation of people with intellectual disabilities.

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