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Emotions at School: Developing a Serious Game for School-Aged Children

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Resumo

A regulação emocional (RE) é uma competência fundamental que se desenvolve desde cedo e é essencial para o bem-estar social, psicológico e educacional das crianças. À medida que entram na idade escolar, as crianças começam a passar de uma regulação orientada por adultos para uma gestão emocional mais autónoma. Esta transição desenvolvimental ocorre em simultâneo com interações sociais cada vez mais complexas e pressões escolares, exigindo respostas emocionais adaptativas. A investigação tem demonstrado que dificuldades de RE nesta fase estão associadas a rejeição pelos pares, dificuldades escolares e maior vulnerabilidade a problemas de saúde mental como ansiedade, depressão e perturbações do comportamento. Por este motivo, a intervenção precoce é essencial para apoiar a integração social positiva, o sucesso escolar e a saúde mental a longo prazo das crianças.

Os programas de intervenção tradicionais, apesar de eficazes, enfrentam limitações ao nível dos recursos, acessibilidade reduzida, estigmatização e falta de envolvimento por parte das populações mais jovens. Assim, a necessidade de novas intervenções que consigam alcançar as crianças e ensinar eficazmente competências de RE é particularmente urgente. Jogos Sérios (JSs) constituem uma ferramenta promissora neste sentido, combinando entretenimento com objetivos educativos ou terapêuticos, e demonstrando benefícios comprovados em áreas como a saúde mental e o desenvolvimento emocional.

Esta dissertação apresenta o desenvolvimento de um JG voltado para a aquisição de conhecimento emocional e competências de RE em crianças em idade escolar. Foi realizada uma revisão sistemática da literatura, seguindo as diretrizes PRISMA, com o objetivo de examinar os JS existentes que abordam a RE em crianças. A revisão identificou elementos recorrentes nos designs analisados, mas também revelou lacunas importantes, incluindo o foco limitado especificamente na RE e a escassa participação de stakeholders no processo de desenvolvimento. Em resposta a essas limitações, o *EmotiToon* foi desenvolvido com base numa metodologia de co-design, estruturada em três fases iterativas com envolvimento contínuo de stakeholders relevantes. Na primeira fase, profissionais de saúde mental (n=5) contribuíram para o design conceptual, orientando a criação de um jogo narrativo em estilo cartoon 2D, estruturado em torno de seis cenários emocionais, concebido para ensinar cinco emoções básicas e três emoções complexas, juntamente com estratégias de RE. A segunda fase consistiu na testagem do protótipo com crianças (n=5), cujo feedback permitiu identificar áreas de melhoria e confirmou elevados níveis de interesse e entusiasmo pelo jogo. A terceira e última fase envolveu a avaliação do jogo por parte de profissionais de saúde mental (n=5) e um designer de jogos (n=1), que analisaram a usabilidade, o valor educativo e a adequação às necessidades do público-alvo. Os resultados da avaliação indicam que o *EmotiToon* promove o desenvolvimento de competências de RE e incentiva a autorreflexão nas crianças, sendo validado pelos especialistas quanto à sua usabilidade e adaptabilidade para aplicação em diversos contextos, incluindo em casa, na escola e em ambientes clínicos.

Palavras-chave: Regulação Emocional, Crianças em Idade Escolar, Jogo Sério

Abstract

Emotion regulation (ER) is a fundamental skill that develops early in life and is essential for children's social, psychological, and educational well-being. As children enter school age, they begin shifting from adult-guided regulation to more independent emotional management. This developmental transition occurs alongside increasingly complex social interactions and school-related pressures, which demand adaptive emotional responses. Research has shown that ER difficulties at this stage are associated with peer rejection, academic difficulties, and higher vulnerability to mental health issues such as anxiety, depression, and behavioral disorders. For this reason, early intervention is critical to support children's positive social integration, academic success, and long-term mental health.

Traditional intervention programs, while effective, face a lack of resources, limited accessibility, stigmatization, and are not sufficiently engaging for younger populations. Therefore, the need for new interventions that can reach children and effectively teach and train ER skills is of most urgency. Serious Games (SGs) present a powerful tool for this purpose, combining entertainment and educational or therapeutic goals, with proven benefits for areas of mental health and emotional development.

This thesis presents the development of a SG for the acquisition of emotional knowledge and ER competencies in school-aged children. A systematic literature review was conducted under PRISMA guidelines to examine existing SGs targeting ER for children. The review identified recurring design elements but also revealed notable gaps, including a limited focus specifically on ER and limited involvement of stakeholders in the design process. In response, *EmotiToon* was created using a co-design methodology organized into three iterative phases with continuous involvement of key stakeholders. In the first phase, mental health professionals (n=5) contributed to the conceptual design, guiding the game to be a 2D cartoon-style narrative game structured around six emotional scenarios, designed to teach five basic and three complex emotions alongside ER strategies. The second phase involved prototype testing with children (n=5), which provided feedback on areas for improvement and confirmed high levels of interest and enthusiasm for the game. The final phase consisted of an evaluation by mental health professionals (n=5) and a game designer (n=1), who assessed usability, educational value, and alignment with the needs of the target audience. Findings from the evaluation indicate that *EmotiToon* supports the development of ER skills and encourages self-reflection in children, with experts validating its usability and adaptability for use in various settings, including homes, schools, and clinical environments.

Keywords: Emotion Regulation, School-aged Children, Serious Game

UN Sustainable Development Goals

The United Nations Sustainable Development Goals (SDGs) provide a global framework to achieve a better and more sustainable future for all. It includes 17 goals to address the world's most pressing challenges, including poverty, inequality, climate change, environmental degradation, peace, and justice.

Among these global objectives, several align closely with the aims of this project, focusing on children's emotional health, education, and equal access to resources:

SDG 3 Supporting children's emotional well-being with a digital tool that complements clinical contexts

SDG 4 Promoting the learning of emotional knowledge and competencies through an interactive SG

SDG 10 Reducing inequalities in access to emotional education with a free and accessible solution

SDG	Target	Contribution	Performance Indicators and Metrics
3	3.1	Offering a digital resource for mental health professionals helps support clinical interventions for children's emotional development.	Qualitative reports regarding clinical usage; Number of professionals intending to use the game in therapy.
	3.2	Promoting early emotional competencies through gameplay helps prevent future ER difficulties.	Expert feedback on the game's preventive potential; Integration of validated ER strategies.
4	4.1	Teaching emotional competencies through game-based approaches facilitates children's emotional learning and supports educational outcomes.	Observed engagement and interest in the game from children; Expert evaluation of content clarity and understanding.
10	10.1	Providing a free and accessible game helps reduce financial and technological barriers to emotional education.	Cross-platform availability; No associated cost to users.
	10.2	Offering a ready-to-use digital tool enables emotional education in contexts with limited therapeutic or educational resources.	Feedback from professionals on applicability in various settings.

Acknowledgments

Despite the difficult times faced during the development, this thesis marks an important milestone in my academic journey. To me it represents more than just a piece of work, it is something I am truly proud of.

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This thesis is not mine alone, as it carries a little piece of everyone who supported me along the way.

Bárbara Carvalho

"It gets easier.
Every day it gets a little easier.
But you gotta do it every day — that's the hard part."

BoJack Horseman

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Abbreviations

ABS	Attitudes and Beliefs Scale
ADHD	Attention-Deficit/Hyperactivity Disorder
AI	Artificial Intelligence
ASD	Autism Spectrum Disorder
CBT	Cognitive-Behavioral Therapy
DLD	Developmental Language Disorder
ER	Emotion Regulation
ERQ	Emotion Regulation Questionnaire
LIACC	Laboratório de Inteligência Artificial e Ciência de Computadores
SDQ	Strengths and Difficulties Questionnaire
SG	Serious Game
SEL	Social-Emotional Learning
SUS	System Usability Scale
TD	Typically Developing
USEQ	User Satisfaction Evaluation Questionnaire
VR	Virtual Reality

Chapter 1

Introduction

1.1 Context

Throughout an individual's life, emotions are always intertwined with daily activities, impacting a variety of areas of human functioning, particularly communication and socialization. This emotional influence extends to our personal and professional lives, shapes our relationships and social interactions, and affects our work performance and general life success [1]. Having the ability to recognize and identify emotions (e.g., joy, sadness, anger) in oneself and others becomes essential, especially for children.

At such a young age, low levels of emotional knowledge can decrease the likelihood that children recognize how others feel and increase the chance that they will choose inappropriate responses [2]. This places children at risk of isolation from or rejection by their peers [2]. On the other hand, children with a greater understanding of emotions demonstrate more pro-social behavior, higher levels of empathy, and greater peer acceptance [2, 3]. Therefore, emotional knowledge is a crucial component that young people must have in their lives to promote more positive development trajectories.

As defended by Gross [4], emotion regulation (ER) refers to the actions that influence which emotions individuals experience, when they experience them, and how they are felt and expressed or might be observed by others. Although emotion dysregulation can sometimes be temporary with no long-term effects, the persistence of ER difficulties can be a predictor of mental health or psychological problems in adulthood, such as anxiety, depression, suicidal thoughts, and aggressive behavior. Managing negative emotions is essential for supporting pre-school and school-aged children with psychological problems or those at risk of developing them. Various studies have emphasized that better ER skills are associated with greater social adjustment and improved academic performance [3]. It is therefore essential to create intervention programs during these developmental stages to prevent psychopathology and foster positive development. The already existing intervention programs generally fall into two main categories: school-based programs or clinical interventions, both focusing on helping children recognize, understand and regulate

their emotions. However, despite the availability of these programs, they face serious limitations regarding accessibility, high costs or resources.

Due to advancements in technology, digital tools such as serious games (SG) have begun to bridge the gaps in accessibility. According to various studies, SGs have proven to be beneficial in a variety of domains, including education, healthcare and social development [5]. These games are designed for purposes beyond pure entertainment, typically to educate, train, or raise awareness on specific topics. Through a game-based approach, children are provided with a more dynamic and creative learning environment that appeals to younger audiences and addresses both cognitive and emotional development, improving motivation and retention when compared to traditional methods.

This project will be developed within the scope of LIACC (Laboratório de Inteligência Artificial e Ciência de Computadores), where previous SGs focused on ER for adolescents and parents have already been created. Furthermore, as it targets school-aged children, this game is intended to complement existing intervention programs within an educational context, given that schools present an opportunity to reach a broad and diverse group of children during their critical developmental years. Additionally, this project aligns with a parallel game being developed aimed at pre-school children, thus expanding the scope of ER interventions across different age groups considering the specificity of each developmental stage.

1.2 Motivation

While intervention programs already exist to address emotional education and regulation in school-aged children, traditional methods are either resource-heavy or difficult to have access. Despite the growing usage and efficiency of interactive technologies, particularly SGs, for psychoeducation, this remains an area where a lot of development and exploration is needed.

Currently, the existing SGs mostly focus on mindfulness or emotional awareness, rather than promoting ER education and skills. On the contrary, this work will be specifically for psychoeducation on emotions and ER skills for school-aged children. Moreover, by adopting a co-design approach in collaboration with health professionals and teachers, parents and children can feel more included, as their needs and preferences will be prioritized.

Compared to intervention programs, capturing the attention and focus of such a young audience becomes easier through a game-based approach, which allows children to safely experiment, make decisions and explore the outcome of emotional interactions through a controlled environment. Additionally, the game can complement existing school programs or stand alone as an accessible digital intervention, especially for children who may not have access to formal programs.

1.3 Problem Identification

The lack of accessible and engaging tools for teaching ER skills to school-aged children presents a challenge in psychoeducation. On top of that, the current resources are insufficient, further exacerbating the problem in reaching all children in need of long-term emotional learning, particularly in school settings where other intervention programs may fall short.

As discussed in the previous sections, ER is critical for child development and mental health, but unfortunately, these serious needs are not being answered by the current intervention programs. Due to the advantage of connecting personally to children at risk of emotional dysregulation or those without access to professional help, schools remain the ideal setting for addressing this issue.

With that in mind, the primary goal for this work is to develop a SG for the acquisition of emotional knowledge and ER skills in school-aged children. This will be achieved through an interactive electronic game designed to provide training with feedback to reinforce learning outcomes. It aims to bring an accessible and engaging solution that will act as a supporting tool for existing school programs, capable of improving emotional skills in children and having long-term benefits such as better social interactions, academic performance, and mental health outcomes.

1.4 Research Questions

To address the problem outlined in the preceding section, it is imperative to explore how psychoeducation on emotions and ER can be integrated into a SG that supports children's emotional development within the school setting. Hence, this work aims to address the following questions:

Q1: What are the key game design elements for adapting emotion regulation into serious games for children aged 6 to 9 years old?

To address this question, the study will conduct a systematic review of existing SGs for ER targeting children, with the aim of analyzing current solutions, including their design strategies and limitations, to identify opportunities for improvement. Furthermore, the involvement of domain experts, such as psychologists and teachers, throughout the game development process ensures the integration of specialized knowledge to create a solution suitable for psychoeducational purposes. This collaborative approach will allow for the selection of age-appropriate game design elements that effectively support ER learning goals.

Q2: Can a serious game improve accessibility, engagement, and ease of use of emotional learning interventions in contexts such as schools?

This question seeks to validate the success of the game in terms of user experience. To achieve this, the study will employ a co-design methodology, involving multiple stakeholders in both the development and testing phases. Healthcare professionals and teachers will evaluate the suitability of the game for the target age group and its feasibility for implementation in school or clinical

settings, addressing accessibility barriers. Parents will infer the utility and involvement of the game by watching their child play. Children, as end users, will provide the most valuable feedback on the fun of the game, the challenge level, and the ease of use.

Q3: How can a serious game contribute to the emotional development of children aged 6 to 9 within school-based or therapeutic environments?

To explore this question, the study will evaluate the effectiveness of the developed SG in promoting emotional development among children. To accomplish this, the game must include mechanisms and strategies for ER that allow children to practice and internalize skills such as emotional differentiation, recognition, and regulation. The study will assess whether the game contributes to greater emotional knowledge and improved ER abilities through pre- and post-test evaluations, capturing both short-term outcomes and the practical applicability of the learned skills in an educational context.

Chapter 2

Theoretical Background

2.1 Emotion Regulation

2.1.1 Emotion Regulation Definition

Over the years, ER has been a central topic of discussion among researchers, raising doubts regarding what it truly encompasses. Initially understood in simple terms as the ability to manage emotions, the concept has evolved with each successive study, building upon previous knowledge. Still, consensus on a standard definition seems hard to achieve, due to the complex nature of the theme and as each author interprets the subject through a specific perspective. A widespread and frequently adopted terminology was first introduced by Thompson, denoting ER as "the extrinsic and intrinsic processes responsible for monitoring, evaluating and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals" [6]. However, further research extended this concept into something more comprehensive, considering the influence of ER not only in one but also in others. Later, Gross defined ER as the processes that influence the emotions an individual has, as well as when and how they are experienced and expressed [7]. Due to its value among the scientific communities, this will be the notion adopted throughout this work.

Beyond its definition, the impact of ER on psychological and physical well-being is also a consistent theme in mental health research. Numerous studies were conducted to investigate the correlation between ER and psychopathologies, revealing that individuals with ER difficulties poorly regulated individuals suffer from longer and more severe periods of stress, raising the risk of disorders such as depression and anxiety [8]. These difficulties are also commonly referred to as emotion dysregulation and comprise the absence of knowledge, awareness, and acceptance of emotions, as well as the lack of ability to control impulsive behaviors during stressful situations and apply adequate ER strategies [9]. Dysregulated emotions or behaviors can have serious repercussions throughout one's life, straining relationships with friends, romantic partners, and other sources of emotional support [9]. When faced with distressing situations, individuals can go as far as turning to food, alcohol, or other maladaptive coping mechanisms in an attempt to regulate their emotions.

2.1.2 Emotion Regulation in Children

To understand how ER competencies are acquired, it is essential to consider their development across the lifespan, shaped by neurobiological and environmental factors. In infancy, infants rely entirely on proximal external sources, primarily their parents or caretakers, for co-regulation [10]. During the primary school years, children experience a notable shift in how they regulate their emotions. As their cognitive and social skills mature, they transition from relying on external support to using more complex and internal ER strategies. Amidst this developmental process, the school environment becomes a critical context, with peer interactions and teacher-student relationships playing pivotal roles. Thus, these years mark an important period for shaping adaptive ER patterns that influence both academic and social integration [11].

Each developmental stage faces unique challenges in ER development, impacting psychological, social, and cognitive outcomes. While for infants, inconsistent or negative parenting responses are associated with increasing risks for future anxiety and dysregulation [9, 10], poor ER in school-aged children links to difficulties in managing social interactions, impulsivity, and academic disengagement [11, 12].

As there is a clear connection between poor ER skills and mental health issues, it is essential to teach children how to adequately acknowledge emotions. Efficient ER consists of applying the most adaptive strategy in each situation, according to the individual and situational goals, meaning that children must develop skills to adopt a flexible use of ER strategies.

2.1.3 Emotion Regulation Strategies

Daily, consciously or unconsciously, people try to influence the positive or negative emotions they are feeling, in an attempt to meet their goals. These actions are known as ER strategies and pertain to how individuals control, express, or change their emotions in different situations. These strategies are a combination of behavioral and mental strategies, which involve actions taken and thought processes, respectively, to change how emotions are experienced [11]. On easier terms, the simple act of taking a deep breath, walking away to calm down, or thinking about a situation in a lighter way are already examples of behavioral and mental strategies to help manage emotions healthily.

Although ER strategies are often chosen with the intent of remaining calm, coping with stressful and highly emotionally demanding situations, or responding to emotions, these choices do not always result in healthy or adequate decisions. According to several studies, ER strategies can be regarded as adaptive and maladaptive, depending on the outcomes generated [13]. While adaptive strategies imply an active involvement in the emotional experience, thus being protective against psychopathologies, maladaptive strategies encompass an attempt to distance oneself from the emotional experience, posing a risk factor for psychopathologies. Despite the commonly made distinction, it is important to note that this does not mean that certain strategies are always adaptive or always maladaptive. Different strategies work for different situations, depending on

each individual and their own goals. The most commonly identified adaptive strategies in the literature include cognitive reappraisal (changing the way one thinks about a situation to feel better), problem-solving (finding ways to fix the issue causing negative emotions), and acceptance (acknowledging emotions without trying to change or suppress them) [8]. These are often regarded as healthy ways of managing emotions while reducing stress and supporting psychological growth in the long term. Alternatively, maladaptive strategies include suppression (pushing emotions away or hiding them), avoidance (staying away from situations that trigger strong emotions), and rumination (repeatedly thinking about negative feelings, situations, or problems without taking action to resolve them) [8]. These are viewed as unhealthy ways of coping with emotions that often worsen distress over time, increasing the risk of long-term emotional struggles.

Particularly for children, if not taught correct manners to regulate emotions, they may default to maladaptive strategies that increase stress and emotional struggles. Taking the example of a child being laughed at by his peers at school, how they handle the situation impacts their emotional well-being. While seeking assistance from adults or staying close to supportive classmates (problem-solving) encourages the child to find solutions instead of internalizing negative feelings, making excuses to stay home instead of addressing the issue and replaying the bullying in their mind (avoidance and rumination) mainly causes more anxiety and fear of school, making the problem worse over time. Thus, teaching adaptive ER prevents psychopathologies and promotes better physical and mental health in the long term.

2.1.4 Theoretical Model of Emotion Regulation

James Gross, a notorious psychologist best known for his research on emotion and ER, proposed the Process Model of Emotion Regulation, represented in Figure 2.1, which the author defends to be "a conceptual framework useful for understanding the causes, consequences, and mechanisms underlying various forms of emotion regulation" [14, 4]. This model identifies five points in the emotion generation process where regulation can occur, corresponding to five families of strategies:

- **Situation Selection**: Choosing situations likely to lead to desirable emotional outcomes.
- **Situation Modification**: Actively changing aspects of the environment to influence the emotional impact of a situation.
- **Attentional Deployment**: Redirecting attention toward or away from certain aspects of a situation without altering the environment itself.
- **Cognitive Change**: Reinterpreting the situation to change its emotional meaning.
- **Response Modulation**: Managing emotional responses after they have already been triggered to regulate their intensity or expression.

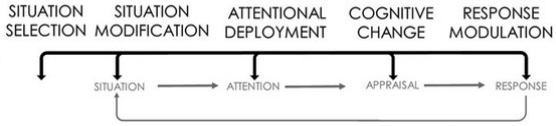


Figure 2.1: Process Model of Emotion Regulation

According to Gross, these strategies follow the logic of the Situation-Attention-Appraisal-Response sequence, which describes how emotions are generated. On simple terms, an emotionally significant situation occurs, attention is directed towards it, an interpretation of the situation is formed, and a response is triggered [4].

Additionally, Gross also categorizes these strategies by when they occur in relation to the emotional experience, distinguishing between antecedent-focused and response-focused [14].

Antecedent-focused strategies are used before the full emotional response is develop, allowing individuals to shape their emotions early in the process, and include situation selection, situation modification, attentional deployment, and cognitive change.

Response-focused strategies are used after an emotion has already been triggered and involve controlling or adjusting the outward expression of emotions, corresponding to response modulation.

This distinction is crucial for understanding how ER can be applied effectively. Antecedent-focused strategies tend to be more adaptive, as they intervene earlier in the emotional process, whereas response-focused strategies are useful in regulating emotions that have already escalated.

2.1.5 Emotion Regulation Interventions in Children

Over the years, several evidence-based mental health interventions have been developed to provide relief, support recovery, and prevent the escalation of mental health conditions [15]. In particular, to promote ER skills in youth, these interventions typically fall into two main categories: clinical and therapeutic interventions, and school-based programs.

One of the most widely used approaches for addressing ER difficulties in children and adolescents involves clinical and therapeutic interventions, specially for those struggling with emotion dysregulation, anxiety, depression, impulsivity, and behavioral disorders. A recent systematic review and meta-analysis examined the effectiveness of current psychological interventions to improve ER in youth, with results indicating that these interventions can enhance ER abilities, and these improvements correlate with reductions in psychopathology [16]. Unfortunately, these factors associated with cost and availability can lead to delayed interventions, which can worsen mental health issues over time.

One other alternative to support ER in children consists of school-based programs. Given that children and adolescents spend a considerable amount of time in educational settings, schools take on a crucial role in teaching students how to manage emotions, handle stress, and build healthy social interactions. In this context, teachers act as the key intermediaries, responsible for educating

students about emotions and self-regulation techniques, creating a classroom environment that acknowledges and supports emotional well-being [17]. To effectively help students, the teacher must invest time in getting to know them individually to understand their emotional vulnerabilities, while maintaining a calm posture to be able to self-regulate themselves and effectively manage classroom interactions. Many educators lack proper training in ER techniques, making it difficult to integrate these lessons into daily teaching. Additionally, while structured programs such as Social-Emotional Learning (SEL) exist, schools often struggle with limited time, resources, and funding, making it difficult to sustain long-term implementation.

2.2 Serious Games

The use of games for purposes other than pure entertainment dates back to the early 1970s, which is often considered the beginning of the history of SGs. The term was first introduced by Abt [18], who defined SGs as those that "have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement". However, even before this formal definition, SGs were already being applied in military contexts to train officers. Over the following decades, technological advancements propelled the expansion of SG applications into various sectors including business, industry, marketing, healthcare, and education leading to exponential growth [19]. With the widespread adoption emerged the need to refine the concept of what constitutes an SG. Although many studies have attempted to delineate the boundaries of the term, a universal classification and terminology remain absent. Some authors recognize the inclusion of both digital and non-digital formats [20, 18], such as board games, card games, and role-playing games, defending that what defines a SG is not the format, but rather its purpose. Despite minor variations in the definition, the common principle across different perspectives is that SGs incorporate game mechanics and design elements that serve a purpose beyond entertainment, particularly the acquisition and practice of knowledge and skills on a certain subject [21, 20].

Another term frequently associated with SGs is game-based learning. While the two concepts share similarities, they are not entirely interchangeable. Game-based learning refers to the use of any game, whether a serious or commercial one, for educational purposes [21], meaning that even games originally designed for entertainment can be adapted to support learning objectives. In contrast, the entire design process of an SG is inherently structured around learning. Therefore, every SG can be used in game-based learning, but not every game used in game-based learning qualifies as an SG.

A recent article [21] explored the reason behind the success of SGs, reasoning that their effectiveness can be explained from four perspectives: motivational, affective, cognitive, and sociocultural. The motivational aspect arises from the player's active engagement, driven by challenges, competitions, and rewards, with immediate feedback and clear objectives. These elements guide the game to meet the psychological needs of competence, autonomy, and relatedness, which ultimately reinforce engagement. The affective perspective emphasizes the emotional impact of games, as there has to be a balance between challenge and skill to create a positive and immersive

experience. Hence, a game can not be too easy to avoid becoming boring, while at the same time not too difficult to avoid frustration. On the cognitive side, games facilitate active learning through experimentation and the use of multimedia elements, allowing the players to experiment, test hypotheses, and apply knowledge. Finally, the sociocultural perspective underscores the importance of social interaction and collaborative learning in the construction of knowledge, on the basis that learning takes place in a social context, and games can simulate real situations where cooperation and communication are essential. Together, these four dimensions make SGs powerful and effective tools for educational purposes.

While understanding why SGs are effective is important, thinking about the design choices and how to combine both educational and entertainment aspects is also a crucial step in the development of an SG. Similarly to the lack of a universal definition, there are also no fixed design principles governing the creation of these games, leaving considerable flexibility for the developers. However, article [22] attempted to propose several fundamental principles for the design, underlining differences from entertainment games. Firstly, the author recommends the involvement of a multidisciplinary team in the design process, including game designers, programmers, artists, and domain experts, to ensure educational relevance. Secondly, the game should be adapted to the target audience, considering characteristics, such as age, gaming experience, and preferences, and including user testing during development to adjust difficulty and playability. Furthermore, the serious content should be integrated in such a way that doesn't make the game seem like just a teaching tool or a game with no educational depth. As emphasized by the aforementioned study, a focus on a balance between fun, challenge, and skill is critical to keep the player engaged. Additionally, simply adding serious elements to an existing entertainment game is not an effective approach because the educational objectives must be deeply embedded within the game mechanics and narrative from the outset.

2.2.1 Applications for Mental Health in Children

Computers, tablets, and smartphones have become ubiquitous in children's everyday lives, making it rare to find a child who does not own or has never used one of these devices. A significant portion of their screen time is spent playing games, which are now an integral part of their entertainment and social interactions. This widespread interest in digital games poses an opportunity for their use as therapeutic tools in mental health interventions. A recent study highlighted the significant increase in smartphone apps designed for mental health support [23], with engaging mechanics that promote adherence and make them more appealing than traditional therapy alone.

Among these applications are therapeutic games, a category within SGs, that integrate entertainment elements while maintaining a primary focus on mental health purposes [24]. These games capitalize on the natural interest children and teenagers have in gaming, thus facilitating the implementation of therapeutic strategies in an interactive format. The desire to progress, whether through unlocking new levels, overcoming challenges, or discovering how the story unfolds propels children to keep playing. Unlike conventional therapy, which may feel intimidating or stigmatizing, therapeutic games provide a less intrusive and more interactive approach that addresses

common concerns such as anxiety, depression, and stress management.

Due to their adaptable and accessible nature, SGs for mental health can be applied in various settings, including clinical environments, schools, and home use, attending to the needs and preferences of each individual. In clinical settings, such as hospitals, and therapy centers, SGs serve as complementary tools for mental health professionals. When integrated into psychotherapy sessions, these games help patients feel more at ease and connected, which might otherwise be difficult to achieve in traditional therapeutic settings. Among the most widely used approaches are Cognitive-Behavioral Therapy (CBT)-based SGs, which guide patients in identifying negative thought patterns, developing coping strategies, and practicing relaxation techniques [23]. In addition to their therapeutic benefits, SGs can function as assessment tools, allowing professionals to observe in-game decisions, emotional responses, and behavioral patterns within a simulated environment [5].

Furthermore, in educational settings, SGs can also be integrated into mental health programs to assist students in the development of ER skills, resilience, and stress management techniques, allowing schools to identify at-risk students and provide early support. Teachers and school counselors can use SGs during group discussions on mental health topics in a way that reduces embarrassment and encourages open conversations among students. A common strategy involves SEL programs that teach children about empathy, conflict resolution, and communication skills through interactive scenarios and role-playing elements. However, for some children, particularly those who may feel uncomfortable discussing mental health in group settings, home-based SGs offer a more private and familiar alternative. These games allow children to play at their own pace, often with the support of parents, and can integrate daily exercises, such as relaxation techniques, and problem-solving challenges. Additionally, continuous practice outside of therapy sessions allows for the maintenance of long-term skills, making interventions more sustainable and widely accessible [5].

The versatility of SGs makes them powerful allies in children's mental health interventions, as they can be adapted to different settings while maintaining their therapeutic and educational value. Their effectiveness is further enhanced when grounded in established theoretical models or psychological frameworks, creating a tool that complements traditional approaches and reaches individuals who might otherwise not seek help.

2.3 Co-Design

Throughout the literature, co-design is frequently used to express the participation and involvement of stakeholders, such as customers, experts, or end-users, in a project or study. Formally, co-design relates to the "active collaboration between stakeholders in designing solutions to a prespecified problem" [25]. This approach is centered around the user, engaging those closest to the issue in the development, design, implementation, and evaluation processes, thereby establishing

boundaries and priorities. Through open communication and equality between all parties, stakeholders can share their lived experiences, enriching the final product not only in terms of improved design outcomes but also in enhanced social inclusion [25, 26].

Alternatively, co-creation and co-production are also widely present in the literature, often leading to confusion regarding their distinct roles. Although they share similarities with co-design, each concept holds a specific meaning and application depending on the field of study. Co-creation is a broader process that extends beyond design, involving the collaboration of stakeholders throughout the entire innovation or development cycle, from problem definition to the design of solutions, implementation, and evaluation [25]. This approach's value lies in participants' active engagement in idea generation, problem-solving, and continuous refinement. On the other hand, co-production is more focused on the delivery and execution of services or products, requiring a shared responsibility between providers and users in the implementation process [25].

Thus, while co-design is primarily concerned with the idea of collaboratively shaping a solution before it is finalized, co-creation involves a broader process of creative problem-solving at all project phases, and co-production emphasizes shared responsibility in service or product delivery. Given these distinctions, this study will adopt the definition of co-design when referring to the involvement of stakeholders.

2.3.1 Applications in Serious Games for Emotion Regulation

The application of a co-design methodology in the development of SGs for ER amplifies the likelihood of the final game meeting users' needs and preferences, thereby improving acceptance and effectiveness. This approach involves iterative design cycles that embody feedback from key stakeholders, including families, caregivers, and experts in education, health, or social services, providing domain-specific knowledge to game developers [27, 28].

Given the stigma often associated with mental health, co-design activities must prioritize the comfort and easiness of participants, with common methods including focus groups, workshops, interviews, and questionnaires, conducted either in person or through virtual sessions [27]. To encourage interactivity, these sessions often incorporate creative exercises such as drawing, storytelling, or storyboarding, facilitated through tools such as whiteboards, maps, or other collaborative technologies. Additionally, activities can be further adapted to the specific user group, accounting for characteristics such as age, cognitive abilities, and health conditions. During these sessions, facilitators need flexibility and patience to adapt to different participant dynamics, while guaranteeing productive and relevant discussions within the allocated timeframe [27].

Despite careful planning, challenges can easily be encountered during the co-design of SGs for mental health, particularly when involving children. Recruitment of participants sometimes becomes lengthy and time-consuming due to ethical approval requirements or funding constraints, which often demand clear and detailed project outlines. Furthermore, children's input during ideation and development stages may not align with their actual needs, as they may struggle to articulate their thoughts clearly [27].

Within the scope of LIACC's research, two SGs for ER were developed using co-design methodologies, each with distinct approaches. The first study [29] focused on creating an SG (Figure 2.2) targeting ER in parents through a two-phase co-design process. This methodology involved adolescents, their parents, and psychologists to gather insights into their personal experiences with video games and technology use at home and in clinical settings. The initial phase consisted of interviews exploring specific aspects, such as "motivating storylines, goal-oriented learning, feedback, rewards, and the inclusion of choice" [29]. The subsequent phase involved a usability assessment of the final game version, performed through online questionnaires administered to healthcare professionals and parents.

Figure 2.2: EmoBalance

In contrast, the second study [30] concentrated on the development of an SG (Figure 2.3) for the promotion of ER skills for both adolescents and their parents using a three-phase co-design approach, consisting of initial interviews, prototype testing, and usability testing. Similar to the first study, this process included adolescents, parents, and psychologists as stakeholders in initial interviews to collect perspectives on ER challenges, game conceptualization, theoretical integration, and design objectives. During the second phase, structured questionnaires were used to perceive stakeholders' opinions of the game prototype, as well as garner suggestions for improvement. Lastly, the final phase consisted of a usability study with the goal of evaluating user experience, identifying potential usability issues in the completed product, and collecting feedback for future iterations.

Figure 2.3: Emotion Odyssey

While some difficulties arose during the co-design approach in these studies, particularly regarding the recruitment of participants, with reduced sample sizes, its value in SG development for ER is undeniable. For instance, in the second dissertation, the participants' feedback directly shaped key elements of *Emotion Odyssey*, such as the escape room dynamics, narrative content, and the emotional challenges. Due to the integration of these inputs, the final game reflected the needs and preferences of its users, thereby achieving high acceptability scores in the usability study, which further indicates that co-design was crucial in producing a meaningful and well-received game.

Chapter 3

A Systematic Review of the Literature

3.1 Introduction

This section provides a comprehensive overview of current research on emotion regulation (ER) in school-aged children, focusing on identifying and analyzing SGs developed for this purpose. Adopting a systematic review approach, this section examines existing SGs aimed at ER in children, exploring how they are designed, implemented, and evaluated in educational, psychological, or therapeutic contexts. To ensure the inclusion of the most relevant studies, the review process followed structured steps for eligibility, selection, screening, and collection.

3.2 Search Strategy

3.2.1 Search Query Formulation Process

In the initial stages of the search strategy, five different search strings were tested across five major databases: PubMed, Web of Science, IEEE Xplore, Science Direct, and Scopus. These search strings varied slightly in terms and combinations to evaluate how each database responded to different keyword structures. The strings were as follows:

QS1: "serious game" AND child* AND ("emotion regulation" OR "emotion")

QS2: "serious game" AND child* AND ("emotion regulation" OR "emotion dysregulation" OR "social-emotional" OR "emotion")

QS3: "serious game" AND child* AND ("emotion regulation" OR emotion)

QS4: ("serious game" OR “game-based”) AND child* AND ("emotion regulation" OR "emotion dysregulation" OR "social-emotional" OR emotion)

QS5: ("serious game" OR “game-based”) AND child* AND ("emotion regulation" OR "emotion dysregulation" OR "social-emotional" OR "emotion")

Each string was evaluated for its relevance and comprehensiveness in retrieving studies pertinent to serious games and emotion regulation in children. Testing across multiple databases helped identify which search strings yielded the most relevant results without an overwhelming number of unrelated articles. PubMed and IEEE Xplore consistently produced fewer, more focused articles

on serious games, whereas Science Direct, generated a higher volume of articles, often including many that did not pertain to emotion regulation. This process ultimately led to insights on the most effective search string that would provide a manageable and relevant body of studies across all databases. A summary of the search performance is presented in table 3.1, which illustrates the outcome and relevance of each string in different databases.

	PubMed	WoS	IEEE	ScienceDirect	Scopus	Total
QS1	13	50	15	584	146	808
QS2	13	56	15	592	155	831
QS3	36	76	18	584	146	860
QS4	72	130	21	1257	223	1703
QS5	28	87	21	1257	223	1616

Table 3.1: Performance of each query based on number of results

3.2.2 Final Search Query

The following search string is the result of the query formulation process: ("serious game" OR “game-based”) AND child* AND ("emotion regulation" OR "emotion dysregulation" OR "social-emotional" OR "emotion").

The keyword “serious game” captures articles specifically designed to teach or promote skills beyond entertainment, often including emotional or social skills. Additionally, with the use of the expression “game-based”, the scope of the search is broadened to include game-based interventions, covering a wider range of studies.

The motivation for the use of the wildcard character (*) after “child” is to ensure that various forms, like “children”, “childhood”, or “child”, are included in the search, narrowing down the results to the ones targeting the child demographic as the primary subject group.

Lastly, the inclusion of the terms “emotion regulation”, “emotion dysregulation”, “social-emotional” and “emotion” direct the search to results related to the specific domain being explored. “Emotion regulation” captures the ability to manage and modify emotional responses, while “emotion dysregulation” allows for studies focused on difficulties or deficits in this skill. "Social-emotional" broadens the scope to include studies on skills related to social interactions and emotional understanding, and “emotion” ensures that any other relevant studies on emotional processing or emotional learning are captured.

3.3 Information Sources

For this exploratory review, several academic databases were explored and the following were selected to be the information sources: PubMed, Web of Science, IEEE Xplore, and Scopus. These data sources were chosen due to their extensive collections of literature in the fields of psychology, education, and technology, which combined facilitate an in-depth exploration of serious games design and game-based interventions for ER.

Science Direct was also initially considered due to its large repository of academic articles. However, it was excluded from the final search strategy, as it generated a significant number of irrelevant results that did not align with the specific focus on ER and serious games for children.

3.4 Eligibility Criteria

This review included studies directly related to serious games or game-based interventions designed in the context of emotion regulation, recognition, or socio-emotional skills. Studies outside this scope, including those that did not involve a game-based approach, were excluded. To maintain a targeted scope, only research focusing on children was considered. Additionally, the study must be conducted in educational, psychological, or therapeutic settings to align with real-world applications of ER interventions.

Only studies available in full text and published in English were included. Furthermore, articles and conference papers that meet these criteria were considered, while duplicated or retracted publications, and summaries from workshops or seminars were excluded.

3.4.1 Inclusion Criteria

The inclusion criteria can be summarized as follows:

- Studies directly related to serious games or game-based interventions and emotion regulation, recognition, or knowledge.
- Research conducted in educational, psychological, or therapeutic settings.
- Children as the primary audience.
- Articles and conference papers.

3.4.2 Exclusion Criteria

The exclusion criteria can be summarized as follows:

- Studies focusing primarily on adolescents or adults.
- Studies focusing on facial emotion recognition without a broader emphasis on emotion regulation.
- Summaries of workshops, seminars, lectures, or tutorials.
- Book chapters or any form of review study.
- Publications that have been retracted or that are not formally published.
- Studies lacking a clear research methodology, findings, and analysis.
- Studies not published in English or without full-text access.

3.5 Selection Process and Results

The selection process began with an initial dataset of 360 records identified. The first step was to remove duplicated entries using Mendeley's automated features, which refined the dataset to 256 unique papers, with 104 duplicates identified and removed.

Next, a screening process was conducted on the remaining unique records to assess their relevance based on the alignment with the study's objectives. Firstly, the title and abstract of each paper were evaluated, resulting in the exclusion of 176 records. The next step was the assessment of eligibility for the remaining records based on the inclusion and exclusion criteria.

Each record deemed ineligible was excluded at the corresponding stage, with detailed notes recorded on the exclusion stage and reason. This step resulted in the exclusion of 63 records, leaving a final collection of 16 papers suitable for inclusion in the literature review.

The PRISMA diagram 3.1 illustrates the described selection process, including the reasons for the records' exclusion.

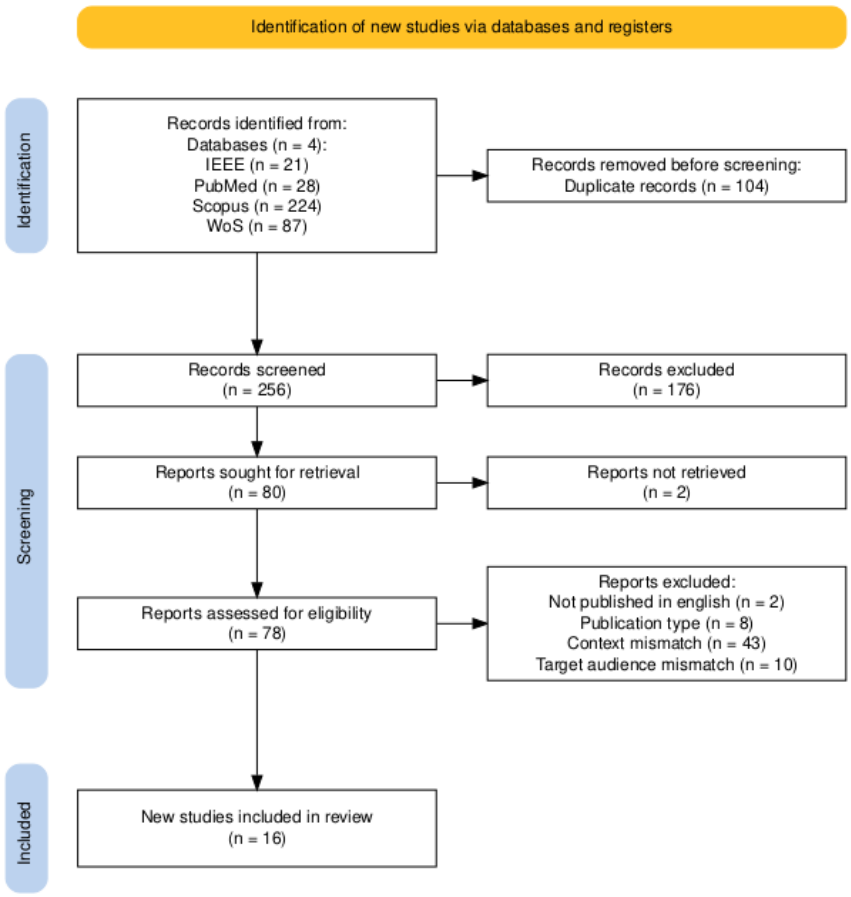


Figure 3.1: PRISMA Flow Diagram

3.6 Content Assessment and Analysis

In this section, a data extraction process was developed, and each study of the final collection was thoroughly analyzed to answer the research questions and the study's goals. The relevant data resulting from this process was categorized based on the following major aspects: game/intervention purpose, game design (summary of its concept and storyline), game mechanics (key features like levels, scoring systems, rewards, challenges, and interactive elements), the platform for which the game was developed or in which it was tested, any specific technology requirements, details on how game instructions/tutorials were included, the context/settings for which it was designed, the type of study performed, as well as the target population, stakeholders who participated in the study, sample size, details about the evaluation techniques used, and the key findings. Following this process, a data extraction table was created with the previously mentioned categories, depicted in Table 3.2.

Table 3.2: SG interventions for ER and emotional skills purposes with children

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[31]	Emotion Detectives	Improve emotion recognition and discrimination skills	Trains recognizing and labeling emotions through interaction with a virtual assistant. Players set up a virtual office, complete tasks, and create personalized cartoons using the "StoryTube" feature.	23 mini-games and 13 social scenarios. Adaptive difficulty (time-limited challenges). Reward system with points. Personalized feedback from Aksu. Final diploma for successful completion.	Not specified	In-game instructions (written or audio) for parents to help their children play.	Home, school or clinics	Longitudinal reversal protocol (ABA research design)	Children with ASD, ADHD and DLD (6-10 years). Parents played together with their children and participated in the evaluation. Experimental group (n=30), Control group (n=20), Neurotypical reference group (n=106)	Emotion discrimination tasks for children. SDQ for parents. Assessment after 2 months of playing. Follow-up assessment 1 month after.	Improved emotion discrimination, recognition and behavioral skills after 2 months of playing, and the skills were maintained.
[32]	Me and Us of Emotions	Evaluate the usefulness of SGs within the intervention program	The SGs were specifically designed for the program. Focused on specific emotions (e.g., joy, sadness, fear, anger) and included characters that the player must guide throughout the scenario.	Collect reward items and avoid obstacles (representing ineffective strategies to deal with the difficult emotion)	Online platform with all the intervention program SGs available.	NA	School	Self-report protocol	Children, 8-12 years (n=232). Teachers, psychologists (n=4). Students within a class were randomly assigned to either an experimental group or a control group	Measures based on subjective appraisals of satisfaction with the sessions.	Similar satisfaction levels with the sessions that did or did not use SGs. Satisfaction with SGs was significantly and positively associated with fun, easiness, ability to understand the session, and ability to cope with emotions.

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[33]	R.E.M.I	Aims to strengthen socio-emotional skills development and promote prosocial behavior.	Uses the IMP. Interactive social simulation game, which is a subgenre of life simulation games that explore social interactions between multiple artificial characters.	Animations: Visuals, music, dialogues. Decision-making: 3 choices each, affects outcomes. Interactive tasks. 3 different endings based on decisions. Playtime: 30-40 min.	Online web-based. Any device. Blender, Unity, Google Firebase, Adobe Illustrator	Well-defined instructions inside the game that can be skipped	School and home	Research protocol	Children, 8-11 years (n= 6-10 per session). Education experts and teachers (n=4), game designers and developers (n=3), child counselor (n=1) and behavior change researchers (n=4)	Future plans: Pre-test survey, final discussion activity and a post-test survey.	Incorporating IMP with stakeholder input effectively guides evidence-based digital game design for socio-emotional skills. Outcomes on skill improvement will depend on future evaluation.
[34]	REThink	Aims to promote emotional health	Theory-based tool based on REBT principles. Lead RETMAN and his 5 allies (representing happiness, tolerance, and acceptance) to combat Irrationalizer and his minions, promoting rational thinking, emotional well-being, and happiness while helping Earth's inhabitants overcome negative beliefs.	7 levels set in diverse Earth locations with increasing complexity. Missions to reclaim territories from Irrationalizer. Activities include belief identification, cognitive restructuring, problem-solving, mindfulness, relaxation techniques, and enhancing happiness-building skills.	Online game. Can be played in any device. Tested on iPad Air 2.	Level Intro: Main character explains goals. Trial Session: Short practice before starting each level.	School	Pilot Study	Children and adolescents, 10-16 years (n=31)	SDQ child version, ABS short form, CASI CATS-N/P, VAS, TS-VAS	Improvements in emotional problems, irrational beliefs, negative automatic thoughts and high levels of intervention satisfaction

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[35]	REThink	The game is targeted at the prevention of emotional problems. The study aims to assess the usability of the game.	Theory-based tool based on REBT principles. Lead RETMAN and his 5 allies (representing happiness, tolerance, and acceptance) to combat Irrationalizer and his minions, promoting rational thinking, emotional well-being, and happiness while helping Earth's inhabitants overcome negative beliefs.	7 levels set in diverse Earth locations with increasing complexity. Missions to reclaim territories from Irrationalizer. Activities include belief identification, cognitive restructuring, problem-solving, mindfulness, relaxation techniques, and enhancing happiness-building skills.	Online game Can be played in any device.	Level Intro: Main character explains goals. Trial Session: Short practice before starting each level.	School	Usability Study	Children and adolescents, 9-16 years (n=330)	Online usability survey. SGES to assess user's experience	Participants reported above-average usability ratings, especially for its narrative.
[36]	Mentis Journey	Help identify and manage their emotions, especially the six basic emotions (happiness, sadness, anger, surprise, disgust, fear)	Players control "Menti," who, with the help of sidekick "Super-Menti," collects and balances emotions scattered across islands. Each island represents an emotion that is out of balance (e.g., volcanic activity for Anger, heavy rain for Sadness).	Levels: Island-based, unlocking emotions via facial expressions. Mini-Games: Emotion Jump, Fruit Basket (challenges, scores, rewards). Rewards: Power-ups, customizable hub items. Gameplay: Resource collection, puzzles, exploration. Style: Bright colors, simple shapes, 2D vector graphics.	PC game played in a browser. Developed in Unity with integrated Face API for emotion recognition, enabling cross-platform accessibility via WebGL.	In-game short introduction to the game controls	Not specified	Research protocol	Children, 6-10 years	The game will be tested in the future	NA

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[37]	Zirkus Emphatico	Foster socio-emotional skills.	Circus-themed world. Virtual mascot (a Fox) guides players through 4 modules for emotion recognition, understanding emotional contexts, and real-life emotional communication using a family-focused interactive animation.	Modules unlock based on the child's progress; open modules can be freely selected. Video-based tasks tied to emotions (fear, anger, sadness, surprise, joy, neutral). Designed to encourage caregiver-led emotional communication.	Online and tablet-based	The Fox mascot provides instructions and explanations. Parent-assisted	Study centers, care unit and at home	Multicenter randomized controlled trial	Children with ASD, 5-10 years (n = 82). One caregiver to assist the gameplay (n=1 per child)	Assessments done through questionnaires at baseline, post-treatment (within the first 2 weeks after the end of the intervention), and at the 3 month follow-up.	Helpful for improving emotional awareness and emotion regulation, and mitigating general autism symptomatology
[38]	REThink	The study investigates the validity of in-game performance measurements as indicators of the game effectiveness in building real life ER abilities. The game aims to improve emotional skills.	Theory-based tool based on REBT principles. Lead RETMAN and his 5 allies (representing happiness, tolerance, and acceptance) to combat Irrationalizer and his minions, promoting rational thinking, emotional well-being, and happiness while helping Earth's inhabitants overcome negative beliefs.	7 levels set in diverse Earth locations with increasing complexity. Missions to reclaim territories from Irrationalizer. Activities include belief identification, cognitive restructuring, problem-solving, mindfulness, relaxation techniques, and enhancing happiness-building skills.	Online game. Can be played in any device. Tested on iPad Air 2.	Level Intro: Main character explains goals. Trial Session: Short practice before starting each level.	School	Pilot study	Children and adolescents, 10-16 years (n=54)	Three assessment sessions: pre-intervention, intermediary, and post-intervention. Questionnaires: SDQ, EATQ-R, ERICA CASI, FD-CMS	Game scoring gains are associated with improved negative and positive emotions, conduct problems, peer relationship problems and ER.

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[39]	EmoAnim	Used for screening purposes between children with autism and normally developing children.	Game Type: Quiz-based. Includes short video clips from popular animations. Challenge: Identify characters' emotions (fear, sadness, happiness, anger). Uses both visual and auditory emotions to simulate real-life situations.	4 levels, increasing difficulty, unlocked based on performance. Environments: Simulated settings (e.g., theater, coffee shop). Customization: Environments can be simplified. Motivation: Voices of encouragement to support players.	Online	The game starts with a visual instruction after the player registers for the game.	Home and clinics	Cross-sectional observational study	25 children (5-10 years): children with autism (n=10) and normally developed children (n=15)	Gameplay performance metrics: correct answer rates, response times, and gameplay patterns across different levels of difficulty.	TD children showed better accuracy and faster response times in emotion recognition. Potential as a tool for distinguishing between ASD and TD children, especially in resource-limited or remote areas.
[40]	Serious Game with Tangible Interfaces	Used as support in the management of emotions.	The game uses TUIs with physical objects to aid in emotion recognition, incorporating elements such as images and RFID cards for interaction.	Players match tangible objects with prompts displayed on a screen. Feedback is given through visual and auditory cues to encourage learning.	Computer with an RFID reading board that interfaces with tangible objects. RFID-based TUIs and software.	Teachers configure activities and supervise sessions. Includes guided tasks.	Educational and therapeutic	Case study	Designed for children with ASD (4-10 years). Tested with: child (n=1, 6 years), special education teachers (n=3), speech therapy teacher (n=1) and parents (n=1)	Questionnaires given to special education teachers to assess the feasibility and usability of the SG, based on serious game usability criteria.	The child successfully identified primary emotions and showed positive engagement. The special education experts confirmed the feasibility and acceptability of the game.

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[41]	Emodiscovery	Aims to evaluate and train interpersonal emotion regulation with the use of virtual characters	Simulation of real-life scenarios with 3D characters experiencing emotions (sadness, anger, fear). Players help improve their emotional states by selecting the right strategies.	Multiple levels/scenarios, each focused on a specific negative emotion. Task: Identify the displayed emotion (multiple-choice). Select from 4 strategies over 3 turns to improve the character's emotional state. Earn stars for correct emotion identification and adaptive strategy choices.	PC	A research assistant introduced and explained the game to the children	School	Cross-sectional experimental study	208 children (8-10 years): n=100 from U.K, n=108 from Spain	Assessment: completed tasks across 3 emotion scenarios. Analysis: emotion recognition accuracy, strategy use, and cultural, age, and gender differences.	Revealed how emotion-specific, cultural, and demographic factors influence emotion regulation in children. Children frequently selected adaptive strategies, demonstrating the game's potential for evaluating and improving social-emotional skills.
[42]	The Park of Emotions	Aims to help in the development of EI	Based on a 9-layered pyramid model of EI. Takes place in a park, a familiar and engaging setting for children, blending fantasy and realism	9 tracks, each targeting a specific emotional skill. Activities: choice-matching, social story problem-solving, emotion recognition games. Progression: collect balloons, released at the end to spread joy. Mechanics:point-and-click interactions. Single-player	Computer.	The in-game assistant explains with speech balloons what to do in each activity, provides feedback, and gives advice each time an activity is finished.	School	Randomized controlled study	Children, 9-12 years (n=436)	EISC (pre-test and post-test) with 1 to 2 months of interval	The intervention significantly improved participants' EI.

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[43]	Digital Touchscreen Game	The study aims to identify the design requirements for the development of a digital touchscreen game with the long-term goal of enhancing awareness regarding their ER	Story-creation activity for exploring ER. Incorporates metacognitive theories for reflection and inquiry-based learning. Character: "Mike," an alien guide, leads players through ER scenarios. Goal: Enhance ER awareness and strategic thinking.	Introduction: Interactive explanations of ER concepts. Players shape narratives by choosing responses, exploring adaptive vs. maladaptive ER strategies. Reflection: Metacognitive discussion on ER strategies, outcomes, and self-regulation, often with adult collaboration.	Touchscreen digital tool	Presents the story and key ER components. Guided questions and prompts to facilitate learning. Adult Support: Ensures comprehension and provides assistance.	Educational and at home	Cross-sectional exploratory study	Children (8-11 years): n=6. Experts to participate in the evaluation phase (n=3).	Experts in psychology and education assessed the game's theoretical and instructional soundness. Workshops with children.	Effectively fostered metacognitive reflection, with children engaging in self-regulation discussions and demonstrating understanding of ER strategies.
[44]	EmoGalaxy	The study aimed to evaluate the effects of EmoGalaxy compared to card games to improve ER.	Intervenes in emotion recognition, expression, and regulation. Each planet focus on one of the emotion categories.	4 planets represent anger, sad, happy, fear emotions that the player should go from one to another one by one to practice emotion. On each planet, there are multiple games.	Computer	Not specified	Clinics	Quasi-experimental study	Children with ASD (6-11 years). Experimental group: n=20, Control group: n=10	ERC	Computer cognitive games led to significant changes in ER in children with ASD.

Study	Game Name	Intervention Purpose	Game Design	Gameplay Mechanics	Platform and Technology	Instructions	Context	Study Design	Target Population, Sample Size	Evaluation Methods	Key Findings
[45]	Emodiscovery	Aims to improve interpersonal ER in children	Simulation of real-life scenarios with 3D characters experiencing emotions (sadness, anger, fear). Players help improve their emotional states by selecting the right strategies.	Multiple levels/scenarios, each focused on a specific negative emotion. Task: Identify the displayed emotion (multiple-choice). Select from 4 strategies over 3 turns to improve the character's emotional state. Earn stars for correct emotion identification and adaptive strategy choices.	Multiplatform online game. Any device. Unity. Blender.	Initial instructions are displayed in the game and are accessible at any point.	Educational and therapeutical	Pilot study	Designed for children (8-11 years) both typically developing and those with high-functioning austism. Tested with children typically developing (n=58)	Choices of regulation strategies, emotion recognition accuracy, and reaction times.	Most children selected adaptive strategies to improve characters' emotions.
[46]	Zirkus Empathico 2.0	Facilitate and provide training to foster socio-emotional and collaborative skills	Circus-themed world. Virtual mascot (a Rabbit) guides players through 4 modules focusing on recognizing one's own emotions, understanding others' emotions, expressing emotions, and engaging in collaborative play.	Step-by-step modules to recognize, express, and apply emotional skills. Difficulty: Adjusts based on performance using an ELO-like system. Rewards: Earned for correct answers and improved performance. Immediate audio and visual hints from the mascot.	Mobile devices, supporting both online and offline modes.	The Rabbit mascot introduces game concepts and provides guidance.	Home and school	Research protocol	Children with ASD	To be performed later	NA

Note: ASD: Autism Spectrum Disorder; ADHD: Attention Deficit Hyperactivity Disorder; DLD: developmental language disorder; SDQ: Strengths and Difficulties Questionnaire; IMP: Intervention Mapping Protocol; ABS: Attitudes and Beliefs Scale; CASI: Child and Adolescent Scale of Irrationality; CATS-N/P: Children's Automatic Thoughts Scale-Negative/Positive; VAS: Problem Solving Abilities - Visual Analogue Scale; TS-VAS: Treatment Satisfaction Visual Analogue Scales; REBT: Rational Emotive Behavioral Therapy; SGES: Serious Game Evaluation Scale; EATQ-R: Early Adolescent Temperament Questionnaire; ERICA: Emotion Regulation Index for Children and Adolescents; FD-CMS: Functional and Dysfunctional Child Mood Scales; ER: Emotion Regulation; TD: Typically Developed; TUI: Tangible User Interfaces; RFID: Radio Frequency Identification; EI: Emotional Intelligence; EISC: Emotional Intelligence Scale for Children; ERC: Emotion Regulation Checklist; NPC: Non-Player Character; UI: User Interface

3.6.1 Study Characteristics

To analyze the collected data, a frequency analysis was conducted for the most relevant categories, which resulted in the following charts. It is important to note that, although the dataset includes 16 different studies, they focus on only 13 unique games, as some studies examine the same game.

3.6.1.1 Year and Quartile

Figure 3.2 represents the number of publications per year and quartile. First of all, there is a noticeable increase in publications starting from 2018, peaking in 2021, and then a decline from 2022 onward. In 2021, most studies came from conferences, outweighing those in quartiles (Q1-Q4), which suggests a strong emphasis on presenting findings during this year. Since the pandemic was a serious matter around the same period, there may be an association between mental health concerns and the number of studies presented. Seeing that the pandemic significantly impacted mental health, emotional well-being, and social connections worldwide, this could have heightened interest in emotional interventions. Furthermore, children suffered the effects of isolation and disrupted schooling, which may have resulted in a greater push to disseminate findings to address these growing concerns specifically for young people. Although, this may be a reasonable connection, none of the examined studies referenced COVID-19. From 2022 onward, there is a shift back to journal publications (Q1 and Q2). In addition, Q4 publications were absent, suggesting less focus on lower-ranked journals.

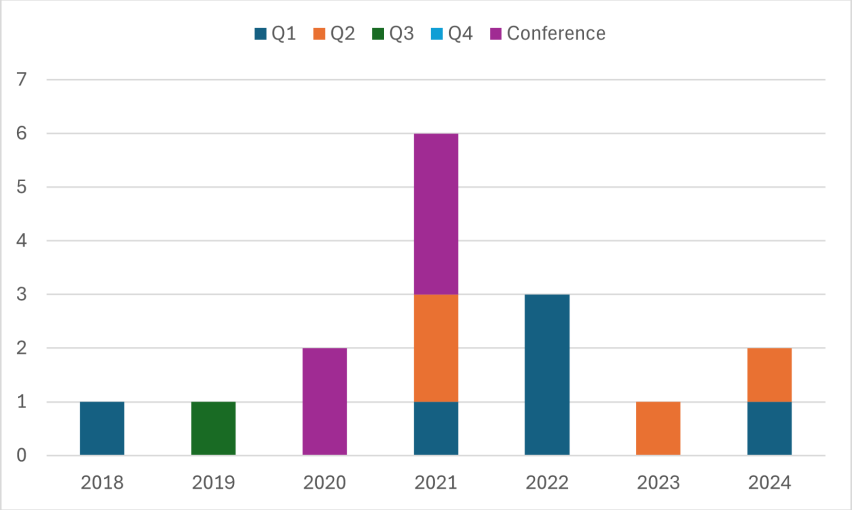


Figure 3.2: Publications by year and quartile

3.6.1.2 Target Population

An analysis regarding the ages of the target population was performed, grouping it into meaningful categories/intervals based on educational and developmental stages to allow better visualization of trends. This resulted in the following age ranges:

- Preschool: 4 to 5 years
- Early childhood / Primary school: 6 to 9 years
- Middle childhood: 10 to 12 years
- Adolescence / High school: 13 to 16 years

Figure 3.3 demonstrates the number of publications per age category targeted. Among the studies, a few were about the same game (n=5, 31.25%), but with different age ranges. Moreover, all publications included more than one age category, excluding one study that did not specify any age [46]. The majority of studies are focused both on early and middle childhood (6-12 years). This suggests that both age groups are key developmental stages for introducing emotional skills. In addition, among studies that included more than one category, a few addressed preschool (n=3, 18.75%) or adolescence/high school (n=3, 18.75%).

In total, there were 1673 participants representing the target population in all studies.

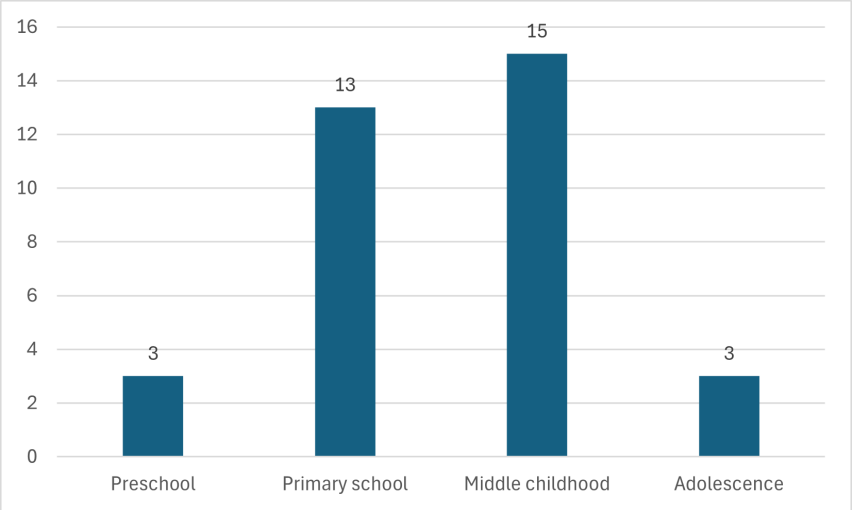


Figure 3.3: Studies by age ranges

3.6.1.3 Stakeholders

The publications were divided into four groups on who else participated in the study in addition to the main target population. As presented in Figure 3.4, the groups considered were parents/-caregivers, teachers (all educational teachers, including special education teachers), and experts (psychologists, game designers and developers, child counselors, behavior change researchers, and speech therapy teachers). An additional category was considered when counting the studies that did not include the participation of other elements, which corresponded to a majority (n=10, 62.5%).

Of all the publications, one (n=1, 6.25%) was developed with the participation of the three groups (experts, parents, and teachers) [40], and two (n=2, 12.5%) included both experts and teachers [32, 33].

Finally, the total number of other elements besides the target population participating in the studies is 106.

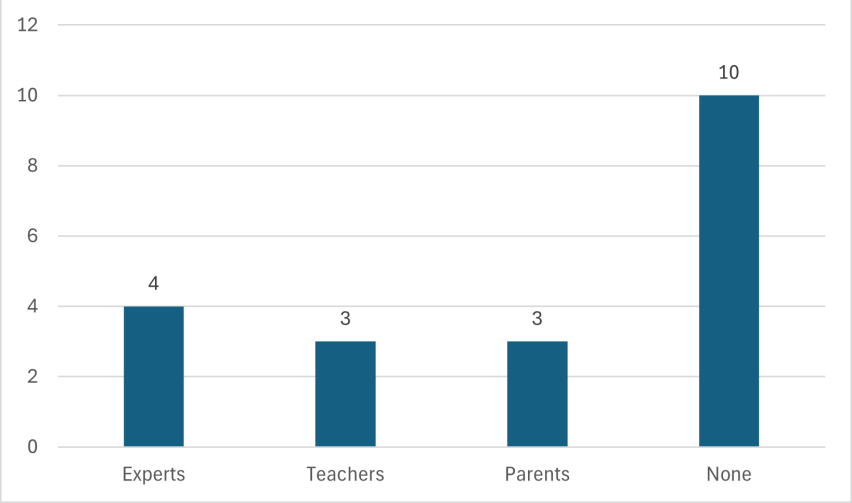


Figure 3.4: Studies by stakeholders participation

3.6.1.4 Medical Conditions

The analyzed studies were categorized into four target groups: Autism Spectrum Disorder (ASD) [31, 37, 39, 40, 44, 45, 46], Attention-Deficit/Hyperactivity Disorder (ADHD) [31], Developmental Language Disorder (DLD) [31], and Typically Developing (TD) children [32, 33, 34, 35, 36, 38, 39, 41, 42, 43, 45]. The majority of publications (n=11, 68.75%) focused on TD children, reflecting a broader applicability of serious games to general populations. Among the medical conditions, ASD was the most frequently targeted, with 7 out of 16 studies (n=7, 43.75%) involving children with this condition. Additionally, one study addressed all three medical conditions, while two studies (n=2, 12.5%) targeted both ASD and TD children, demonstrating an overlap in the design and applicability of certain serious games across different populations.

3.6.2 Serious Games Characteristics

Serious games exhibit a wide variety of designs, objectives, and applications, showcasing their adaptability in promoting emotional skills and addressing developmental needs in children. This section explores the key characteristics of serious games, including their conceptual foundations, gameplay mechanics, platforms, technologies, and targeted populations. Additionally, it examines the contexts in which these games are deployed and evaluates their effectiveness, providing a comprehensive understanding of the elements that contribute to their success.

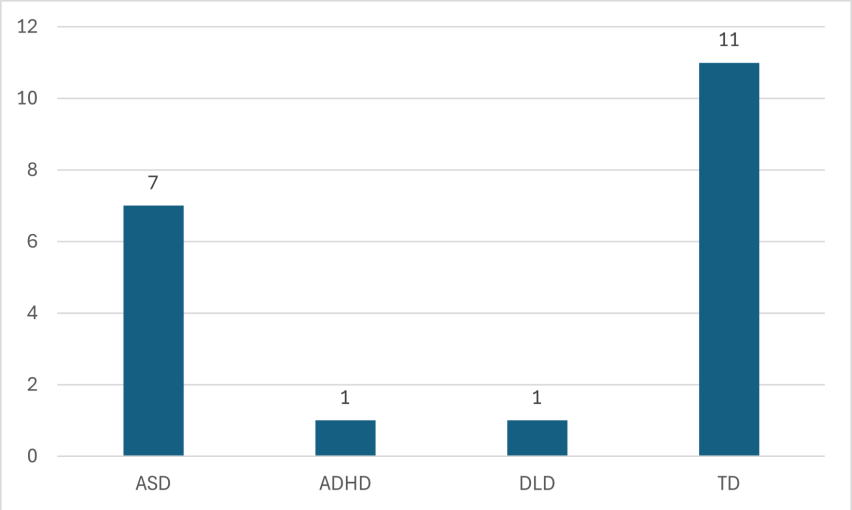


Figure 3.5: Studies by targeted medical conditions

3.6.2.1 Design

The serious games analyzed in the studies are built around immersive and relatable concepts designed to foster emotional skills, including emotion regulation, recognition, and broader socio-emotional development.

Commonly, these games use narrative-driven storylines to sustain player's attention and make the learning experience more engaging. Emotion Detectives [31], for instance, positions players as detectives solving emotional puzzles with the help of a virtual assistant, allowing them to explore emotions through playful scenarios. Similarly, Mentis Journey [36] takes players on an island-based adventure where each island represents a specific emotion that must be balanced, integrating a metaphorical journey with emotional growth.

Another recurring concept among the explored games is the integration of real-life emotional scenarios. While Emodiscovery [41, 45] uses characters in realistic situations, Zirkus Emphatico [37, 46] adopts a family-focused narrative with interactive animations. Even though the scenarios are different, both games immerse players in relatable contexts.

Overall, the concepts behind these games revolve around guiding players through a structured progression of emotional challenges, with many games incorporating themes of self-discovery or helping others.

3.6.2.2 Mechanics

A common mechanic across more than half of the explored games is decision-making, which essentially allows players to actively interact with the environment and explore the consequences of their choices. For instance, R.E.M.I. [33] and Emodiscovery [41, 45] include tasks where players select strategies to influence outcomes, teaching emotion regulation through trial and error. Thus, this interactive approach encourages critical thinking and emotional reflection.

Another feature incorporated by several games is adaptive gameplay. Zirkus Emphatico [37, 46], employs adaptive difficulty levels that adjust challenges based on player performance and abilities. Above all, for special audiences like children with ASD, this becomes critical, since it ensures engagement without overwhelming or frustrating players. Similarly, many games incorporate progression through increasingly complex levels to provide a sense of accomplishment and keep more advanced players engaged. REThink [34, 35, 38] unravels through gradually challenging levels where players confront negative beliefs, fostering emotional resilience over time.

Moreover, most serious games include immediate feedback as a core mechanic, helping players learn from mistakes and reinforcing correct choices. These mechanisms typically range from characters providing verbal encouragement to visual cues such as stars or points. For example, Mentis Journey [36] uses scoring systems to guide learning. Usually, games that include these mechanisms also include reward systems (e.g., The Park of Emotions [42]) that act as incentives, maintaining player engagement and reinforcing desirable behaviors. These systems are based on coins, points, or access to new levels and provide a sense of accomplishment for completing tasks and making correct choices.

3.6.2.3 Platform

The serious games analyzed in this research were developed for a range of platforms, including mobile devices (smartphones and tablets), computers, and touchscreen tools. However, some games (n=3, 23.08%) did not specify the platform for which they were designed, leaving room for ambiguity in their intended usage (e.g., Emotion Detectives [31], Me and Us of Emotions [32], EmoAnim [39]). Additionally, a smaller part (n=2, 15.39%) is intended to be played on any device, showcasing flexibility across different platforms (e.g., R.E.M.I. [33], REThink [34, 35, 38]).

Computers emerged as the dominant platform for almost half of the games (n=5, 38.46%), likely due to their capacity to handle complex visuals and mechanics (e.g., Mentis Journey [36], Serious Game with Tangible Interfaces [40], Emodiscovery [41, 45], The Park of Emotions [42], EmoGalaxy [44]). Mobile devices, such as tablets and smartphones, were also utilized, though to a lesser extent. These platforms offer simplicity and accessibility, making them especially appealing to younger audiences who may find advanced devices or complex interfaces challenging.

Another subset of games (n=2, 16.67%) was web-based, designed to be played through internet browsers (e.g., R.E.M.I. [33], Mentis Journey [36]). This approach, while less common, offers flexibility and ensures compatibility across platforms. Additionally, considering internet access, nearly half of the games (n=6, 46.15%) can be played online, allowing for remote access and broader reach (e.g., Me and Us of Emotions [32], R.E.M.I. [33], REThink [34, 35, 38], Zirkus Empathico [37], EmoAnim [39], Zirkus Empathico 2.0 [46]).

While most games rely on traditional digital interfaces, a few games explore emerging technologies, such as tangible interfaces and digital touchscreen tools. These innovations hold promise for creating immersive, multisensory experiences but remain less prevalent in current studies due to their specialized requirements and limited scalability.

3.6.2.4 Technologies

Most of the analyzed studies don't provide a lot of information on technologies used to develop the games. Nevertheless, Unity and Blender are among the most commonly used technologies to create visually engaging game designs. Unity, a flexible and cross-platform game engine, was frequently employed due to its capability to handle diverse gameplay mechanics, including animations, adaptive difficulty, and decision-making systems. Blender was often used for modeling visually appealing 3D characters and environments, as well as creating animations.

Furthermore, additional technologies, such as Google Firebase, Adobe Ilustrator, and Face API, enhance the games' functionality. Google Firebase and Adobe Ilustrator were incorporated into R.E.M.I [33] for storing information on a database and for creating the graphical user interface, respectively. As for Face API, it was integrated into Mentis Journey [36] to enable emotion recognition. Additionally, this last game also includes accessibility-focused technology, specifically WebGL for browser development, ensuring compatibility across devices without the need for extensive installations.

3.6.2.5 Context

Serious games can be deployed in various settings, depending on their application and goal. Based on the reviewed studies, three primary contexts emerged: schools, homes, and clinical or therapeutic settings. However, only 15.38% (n=2) of the games are suitable to be deployed across the three contexts (e.g., Emotion Detectives [31], Zirkus Empathico [37]).

Educational settings (n=10, 76.92%), including schools and study centers, represent the most common context for serious game deployment. For instance, games such as The Park of Emotions [42] and Me and Us of Emotions [32] were designed for use in classroom activities, where teachers or facilitators guide gameplay.

Additionally, a smaller portion of the analyzed games (n=5, 38.46%) are home-based deployed. Games like Emotion Detectives [31] are intended for home use, often with caregiver involvement and active participation in the gameplay.

Clinical or therapeutic environments are also a notable used context for serious games (n=6, 46.15%), particularly for children with developmental conditions such as ASD or ADHD. In these settings, professionals such as therapists or counselors oversee gameplay and tailor interventions to the individual needs of the child. For example, EmoGalaxy [44] is used in clinical settings to support children with ASD in improving emotion recognition and regulation skills.

3.6.2.6 Target Population

The serious games analyzed were designed for a variety of target populations, addressing both TD children (e.g., Me and Us of Emotions [32], R.E.M.I. [33], REThink [34, 35, 38], Mentis Journey [36], EmoAnim [39], Emodiscovery [41, 45], The Park of Emotions [42], Digital Touchscreen Game [43]) and those with developmental conditions such as ASD, ADHD, and DLD (e.g.,

Emotion Detectives [31], Zirkus Empathico [37], EmoAnim [39], Serious Game with Tangible Interfaces [40], Emodiscovery [41, 45], EmoGalaxy [44], Zirkus Empathico 2.0 [46]). Many games focused on TD children, aiming to build general emotional skills such as emotional intelligence, recognition, and regulation, as seen in The Park of Emotions [42] and Me and Us of Emotions [32].

Several games specifically targeted children with developmental challenges, with ASD being the most commonly addressed condition. Games such as Zirkus Emphatico [37, 46] and Emotion Detectives [31] included features like adaptive difficulty and caregiver involvement to cater to the unique needs of this population. Only one game was developed specifically for children with ADHD or DLD.

In terms of age ranges, most games were designed for children aged 6-12, aligning with key developmental stages in early and middle childhood, and the research focus. However, games specifically targeting younger children within the 6-9 age range were less common.

3.6.2.7 Effectiveness

Regarding effectiveness, the explored serious games were evaluated through a variety of methods, including behavioral assessments, standardized questionnaires, gameplay performance metrics, and pre- and post-intervention questionnaires. These evaluation approaches provided insights into the impact of the games on emotional skills, behavior, and user satisfaction across different target populations.

Some examples of standardized questionnaires to assess emotional and behavioral outcomes include the Strengths and Difficulties Questionnaire (SDQ) employed for the game Emotion Detectives [31], and Attitudes and Beliefs Scale (ABS) and the Children's Automatic Thoughts Scale (CATS) utilized in REThink [34] to evaluate emotional health and irrational beliefs.

Moreover, pre- and post-intervention assessments were often conducted to measure the impact of the games. For instance, for The Park of Emotions [42], a questionnaire was used before and after gameplay with one to two months of interval to track improvements in emotional intelligence, while for Zircus Emphatico [37] baseline, post-treatment, and follow-up assessments were performed to evaluate emotional recognition and regulation skills.

Alternatively, some games incorporated in-game performance metrics to assess learning and skill development. For example, besides using questionnaires, REThink [38] also analyzed scores and progress within the game as indicators of real-life improvements in emotion regulation abilities.

Even though a few studies didn't perform an evaluation and only presented the design process, there were noticeable improvements in emotion recognition, regulation, and socio-emotional skills in several of the analyzed games, with some maintaining the results at follow-up. Additionally, studies like Me and Us of Emotions [32] also reported high levels of engagement and satisfaction.

3.7 Conclusions

The exploration of serious games as tools for fostering emotional development in children has revealed both the potential and complexity of this emerging field. Through the reviewed studies, it becomes evident that serious games are not only versatile but also highly adaptable in addressing a variety of developmental and therapeutic needs.

One of the most striking observations is the diversity in the concepts and storylines of serious games, often incorporating immersive narratives and relatable scenarios to engage children in emotional learning. In particular, the simulation of real-life emotional situations provides children with a safe space to practice recognizing and managing emotions, consequently ensuring that the emotional skills learned through gameplay can be more easily transposed to real-world interactions. However, the richness of these storylines varies, with some games emphasizing emotional depth while others lean toward simplicity and accessibility, reflecting the broad spectrum of their intended audiences.

Regarding mechanics, features like decision-making, adaptive difficulty, and immediate feedback are pivotal to the success of these games. Combined with rewards, progression systems, and interactive tasks, these mechanics help sustain engagement while reinforcing positive learning.

Additionally, the analysis of platforms and technologies indicates that while computers dominate as the primary platform most likely due to their capacity for handling complex visuals and mechanics, mobile devices and web-based solutions are increasingly utilized for their accessibility and portability. Indeed, the flexibility of these platforms is particularly beneficial in enabling deployment across education, home, and clinical settings. Yet, many studies lack a more in-depth discussion of how platform choice impacts learning outcomes or engagement, leaving a gap in understanding the role of technology in enhancing or limiting the games' effectiveness. Additionally, the limited integration of advanced technologies like Virtual Reality (VR) or Artificial Intelligence (AI) suggests that the full potential of serious games has yet to be realized.

In terms of target population, the reviewed games primarily focus on typically developing children and children in the autism spectrum, with the overlapping use of some games for both groups. Moreover, the age range of 6-12 years emerges as a critical period for emotional skill-building, aligning with the developmental focus of most games. However, since children are continuously going through developmental changes, often not at the same rate, considering big age ranges could reduce the effectiveness of these digital interventions. Consequently, future research could further refine the age range, especially for children between 6-9 years, to better address and focus on the specific needs of these smaller groups.

The context of deployment further underscores the adaptability of serious games. Schools are one of the most common deployment settings for implementing interventions, with teachers or facilitators often guiding the gameplay, benefiting students both from the collaborative atmosphere and the opportunity to apply socio-emotional skills in peer interactions. On top of that, when the goal is fostering emotional development on a larger scale, the educational settings allow

for regular monitoring and feedback. Homes serve as an important setting that encourages parents to engage in gameplay with their children, enhancing the learning experience and reinforcing emotional skills in a familiar and comfortable environment. In particular, families who might face barriers to accessing formal interventions greatly benefit from the accessibility that such context offers. On a professional level, clinical or therapeutic settings count on specialized professionals, like therapists or counselors to overview the gameplay and tailor interventions to the individual needs of mostly children with developmental conditions. Nevertheless, despite offering a controlled nature, therapeutic settings may be limited to specific populations, facing difficulties when targeting typically developing children.

The effectiveness of serious games is supported by consistent evidence of positive outcomes, including improvements in emotion recognition, regulation, and socio-emotional skills. The studies report high levels of engagement and satisfaction among participants. However, a notable limitation is the variability in evaluation methods, which makes it difficult to compare results across studies. Most studies rely on pre- and post-intervention assessments, with limited use of longitudinal designs to track long-term retention of skills. Future research could prioritize standardized evaluation frameworks and explore the sustained impact of serious games over extended periods.

In conclusion, serious games have gained significant popularity in the field of mental health as an innovative and easily accessible tool, sometimes having even greater results than traditional methods. Due to their adaptability, engaging design, and evidence-based effectiveness, these games are positioned as valuable resources in both educational and therapeutic contexts. However, there is still room for growth particularly in refining the target populations and exploring the potential of emerging technologies. The continuous innovation of these tools can further bridge the gap between traditional interventions and the dynamic needs of diverse audiences.

Chapter 4

Proposed Solution

This chapter introduces the proposed solution, addressing the gaps identified in the literature through a creative and innovative approach. It encompasses sections that detail the project goals and requirements, the chosen methodology, the phases of development, and the evaluation measures used to assess the solution's effectiveness. Additionally, the chapter includes a discussion of potential study limitations and mitigation strategies to ensure the project progresses smoothly and achieves its intended outcomes.

4.1 Approach

From early ages, the acquisition of emotional skills and competencies is a crucial step for children's mental health development. It has been shown that early interventions greatly impact individuals at risk of emotion dysregulation, reducing the emergence of psychological problems, such as anxiety or depression. Due to the seriousness of the problem at hand, the need for effective solutions accessible to anyone emerged to bridge in the gaps of limited professional help. Thus, SGs became a relevant topic regarding health interventions thanks to its dynamic nature and appeal to younger audiences. However, emotional learning is a broad field with a vast number of skills that can be targeted, meaning that, when developing an intervention, the risk of being too broad must be considered, and consequently, the impact it will have on the game's efficiency.

Throughout a comprehensive literature review, it became clear that ER is not a skill usually targeted on its own. Most of the existing SGs focus on socio-emotional or emotional recognition, but few actively teach children ER strategies. While socio-emotional awareness and acceptance are important, these games are primarily aimed at reducing emotional reactivity rather than teaching children how to handle difficult emotions in real-life situations. The same goes for SGs focusing on emotion recognition, where children learn to identify emotions in themselves or others based on facial expressions or body language. This skill is foundational for social interaction, as it helps young people understand how their peers feel, yet recognizing an emotion doesn't necessarily translate into managing it effectively [47]. For instance, a child who recognizes they are feeling angry (emotion recognition) may still react impulsively if they lack the skills to regulate their anger

[47]. Rather than simply being aware of emotions, ER goes beyond that and involves actively managing emotions in a way that promotes positive social interactions and well-being [4].

Following this gap, the proposed solution to be developed is a multi-platform SG designed for the acquisition of emotional knowledge and ER skills in school-aged children. Literature has illustrated that SGs for children can be deployed in a variety of platforms. Since children come from diverse socioeconomic backgrounds, and not all families have access to the same devices, a game that runs on both high-end (e.g., computers) and low-end devices (e.g., mobile phones, tablets) ensures a wider and diverse range of users. Moreover, children are more likely to engage with a game if it's available on the devices they are familiar with.

The game will provide scenario-based learning, allowing children to practice applying different regulation strategies to improve emotional outcomes. Through this approach, the goal is the translation of the acquired in-game skills to real-life situations where children face peer conflict, academic stress, or disappointment. To reinforce learning, the research showed that a feedback system is critical and encourages behavior change. Since ER is a complex skill that requires continuous practice, feedback helps children reflect on their actions and make better choices over time. This mechanism will be present in the game through visual and emotional cues. Furthermore, another feature that is common to the existing SGs and will be incorporated into this solution is progress tracking (e.g., stars earned, levels completed), which contributes to the child's sense of accomplishment. Given the target age range, the reading skills of younger children can be a limitation that should be taken into consideration in the proposed solution. In order to accommodate these special needs, the game will include audio instructions, ensuring they can follow the game without assistance. Essentially, each task or dialogue bubble can have an audio playback option, allowing children to hear the instructions if they prefer.

The review of the literature shows that most SGs only include end-users' participation during the testing and evaluation phases, with limited to no input during the design phase, which can lead to issues in fully addressing the needs of their users. In contrast, the proposed approach involves a co-design methodology, counting on the participation of multiple stakeholders at every stage of development, with emphasis on the design process, ensuring the game is not only educational but also usable, adequate, and enjoyable for children. Through the integration of feedback at every stage, the game will be designed and refined based on real-world needs and user preferences, reducing the risk of misalignment between the game's goals and user expectations. This process and its details will be better explained in the next subsection.

4.2 Methods

The design and development of the game is based on a co-design methodology, and will include exploratory studies focused on co-creation and usability evaluation with direct involvement of stakeholders, combining both qualitative and quantitative data collection techniques. This method is one of the most relevant and innovative aspects of the project, as it does not treat users as just test subjects, but as equal partners in decision-making.

In a co-design approach, end-users, domain experts, and facilitators are directly involved throughout the development process of the game, providing relevant inputs to generate ideas and solutions [25]. As a result of this involvement, all relevant voices are heard and taken into account, making the final game more likely to be accepted, attractive, and engaging to users, since they had a hand in its creation. Additionally, rather than relying solely on the concepts learned from the literature review, the experience and knowledge of domain professionals shape the design of a solution that is educationally, age-appropriate, and engaging for young learners.

Throughout the following subsections, a detailed plan outlining the implementation of the co-design approach will be presented. The process begins with identifying the key stakeholders who will contribute to the co-creation of the SG on ER for children. The subsequent phases of the co-design process will include interviews and interactive sessions in which stakeholders share their insights, experiences, and preferences to effectively shape the design and content of the game.

4.2.1 Participants

The stakeholders chosen for this project include children, their parents or guardians, teachers, and healthcare professionals such as psychologists. Since children are the primary end-users of the SG, their involvement is crucial to learn what they find fun, understandable, and motivating, helping shape the narratives, characters, and challenges accordingly. Seeing that their young age might make it difficult for them to fully express and communicate all their needs, the participation of parents allows for the clarification of their child's emotional difficulties by providing insight into how children process emotions at home, including common emotional challenges. Their input offers essential knowledge regarding the emotional strategies that work best in real-life scenarios and how the game can be used at home to reinforce ER skills.

Additionally, due to the educational context of this project, teachers are also key stakeholders, bringing practical knowledge about how a new digital intervention for ER could be introduced into school curricula or complement the existing emotional learning interventions already integrated in school settings. Besides helping ensure that the game's content is educationally relevant, teachers also have experience managing group dynamics and can offer strategies for addressing emotions in a social setting.

Moreover, to validate that the game includes appropriate ER techniques and that the content is aligned with the best practices in child psychology, the co-design process also involves healthcare professionals. The participation of psychologists, therapists, and other field professionals brings expert knowledge in child development, emotional competencies, and mental health, further supporting the game's intervention safety, effectiveness, and adequacy to the targeted ages.

Regarding the recruitment process, the study will be presented to potential participants through email communications and/or information leaflets, with recruitment taking place in schools and study centers. Although the project is proposed to be implemented in educational contexts, leisure centers and clinics are also being considered to include clinical populations and allow for comparative analysis. On top of that, the process will only consider children aged 6 to 9 years old,

who are able to communicate thoughts and emotions verbally during the interactive co-design sessions. For the inclusion of parents, teachers, and healthcare professionals, participants must have the availability to participate in interviews, and a willingness to share their experiences, insights, and suggestions regarding emotional learning. In addition to availability, parents should be primary caregivers who have regular interaction with their children and significant involvement in their children's daily emotional development. For teachers, the inclusion criteria will focus on educators with experience teaching children, particularly those familiar with emotional learning strategies. Finally, healthcare professionals must have relevant expertise in child psychology.

For children participating in the co-design process, written informed consent will be obtained from their parents or guardians. Additionally, given the age of the children, verbal informed assent will be obtained directly from them to ensure they understand the nature of the study and are willing to participate. Written informed assent will also be obtained from parents or guardians for their own participation in the co-design process. For teachers and healthcare professionals, a convenience sampling method will be used to recruit participants. On account of clarity and transparency, all participants will receive comprehensive information about the study's goals, procedures, and ethical considerations, including key elements such as voluntary participation, confidentiality, and the right to withdraw from the study at any time. Furthermore, opportunities for questions and clarifications will be provided to guarantee participants fully understand their role in the study.

It is important to note that no financial incentives or rewards will be offered to participants, emphasizing the voluntary nature of participation, and aim to recruit individuals who are genuinely interested in contributing to the development of a SG for emotional learning.

4.2.2 Procedure

The study will be conducted in three phases, corresponding to three co-design sessions, with a minimum of 10 participants for each co-design stage and 25 participants for the usability evaluation phase. This sample size is based on the U.S Food and Drug Administration (FDA) guidelines, which recommend involving at least 25 individuals to identify 90-97% of usability issues effectively [48].

Sessions with parents, teachers, and healthcare professionals will be held either online or in person, depending on their preference and availability. In contrast, sessions with children will take place in educational and clinical settings. In educational contexts, the research team will conduct direct data collection with children, while in clinical settings, sessions will be facilitated by a healthcare professional to prioritize children's comfort and support throughout the process.

At the start of the study, parents, teachers, and healthcare professionals will be asked to complete an online sociodemographic questionnaire. For parents, the questionnaire will include an additional section to gather demographic data about their child.

4.2.2.1 First Phase of Co-design

The first phase of the co-design process consists of a conceptual design and aims to gather conceptual suggestions and design ideas for the development of the initial version of the SG. Parents, teachers, and healthcare professionals will participate in semi-structured interviews, focusing on the emotional challenges they observe in children, and offering recommendations on game design elements that should be included to address these challenges. The interviews will explore their insights on common emotional situations, useful ER strategies, and ways to make the game engaging and practical for children in both educational and clinical contexts.

For children, the focus will be on creative exploration activities to gather early concepts for the game based on their input, and thus guiding the design to be relatable and age-appropriate. To begin the session in a comfortable and engaging way, children will be introduced to the study through playful and imaginative exercises (e.g., drawing a favorite emotion) that will serve as a light-hearted way to approach the topic under study and start a conversation about emotions. Through methods such as storytelling, drawing, and brainstorming, children will be asked to imagine and design fun characters and scenarios where, for instance, one character should help another handle an emotional situation. These drawings and ideas will be used as a foundational concept for the game, particularly regarding the narrative and visual style of characters and scenes, with interactions that resonate with their emotional experiences.

4.2.2.2 Second Phase of Co-design

For the second phase of the co-design process, an initial prototype of the game will already be developed, built upon the concepts gathered in the previous phase. In this phase, all participants will have the opportunity to test the initial version of the game and provide constructive feedback on gameplay, storyline, and overall experience. The goal of the prototype testing is to identify usability issues, refine design elements, and determine if the game is engaging and adequate for children in the target age group.

Parents, teachers, and healthcare professionals will complete an online open-ended questionnaire to share their opinions and suggestions on the game prototype, covering gameplay mechanics, character design, engagement level, and the perceived educational value of the game. As a result, their feedback will help identify areas for improvement, particularly in terms of usability, educational alignment, and practical implementation in both at-home and school environments.

While playing the game, children will be asked simple, open-ended questions (e.g. “What do you think about this part of the game?”, “Is it fun? Is it too easy or too hard?”) to gather real-time feedback during gameplay and further identify potential difficulties they encounter. After testing, in order to help children articulate their thoughts, they will participate in interactive feedback activities where they will be invited to describe or illustrate their ideas for improving the game, helping to refine the design. The session will be guided by structured questions such as “What was the most fun part of the game?”, "If you could change one thing in the game, what would it be?”, and "What kind of rewards would you like to get when you play well?”.

4.2.2.3 Third Phase of Co-design

At the start of the third and final phase of the co-design process, the game is expected to be completed and ready for the usability testing to assess its acceptance, feasibility, and potential impact on children's ER skills.

During this phase, children will be introduced to the final version of the game, learning its concepts and mechanics through an initial guided session, with opportunities to ask questions at any time and explore the game's content. Throughout this activity, the research team will observe the child's behavior and reactions to identify any areas that may need further refinement, and ask simple, open-ended questions to understand how the child feels about the game and whether they find it engaging and easy to play. Such questions include, for instance, "How do you feel when playing this part of the game?", "Is it easy or difficult to understand what to do?", and "Do you like the characters and what they do?". After this introduction, children will take the game home for a week, where they can play freely at their own pace and stop whenever they feel uncomfortable. Parents and children will be informed that they can contact the responsible researcher if they encounter any doubts, problems, or issues related to the game during the week.

At the end of this week, a follow-up session will be held with the children, during which they will complete a paper-based usability questionnaire to provide structured feedback on their experience with the game. Moreover, to make the session more dynamic and less formal for children, they will be encouraged to share their opinions and suggestions openly, through an easy-going conversation guided by structured questions, namely "What did you like most about the game?", "If you could change something in the game, what would it be?", "Did you find the game easy to play?", "Would you play the game again?" and "Would you tell your friends to play it too?".

Similarly, parents, teachers, and healthcare professionals will also be asked to test the final version of the game and present their observations through self-report questionnaires and open-ended questions, covering areas such as game usability, engagement, educational value, and recommendations for improvements. In addition to usability feedback, parents will also fill out an ER questionnaire about their child's emotional skills at two points in time: once before their child starts playing the game and again at the end of the week. This pre- and post-test assessment will help evaluate whether playing the game has had any measurable impact on the child's ER abilities.

4.2.3 Data Collection

The data collection methods will be tailored to each participant group (children, parents, healthcare professionals, and teachers) to ensure that the process is appropriate for their age, role, and availability. In particular, data from children will be collected through paper-based formats, while parents, healthcare professionals, and teachers will complete their questionnaires in online formats to facilitate convenience and participation.

To summarize, as planned for the three phases of the study, data collection will involve the following components:

- Semi-structured interviews to be conducted with parents, teachers, and healthcare professionals during the first phase to gather their experiences and opinions regarding emotional challenges in children, and game design elements;
- Open-ended questionnaires to be filled by parents, teachers, and healthcare professionals in the second and third phases, with the goal of collecting detailed feedback on the game's usability, content, and overall engagement;
- Hetero-reported questionnaire to be completed by parents in the third phase to assess their child's ER behaviors both before and after the gameplay period, allowing the measurement of potential changes in skills as a result of playing the SG;
- Self-report questionnaires to be filled in the third phase by children, parents, teachers, and healthcare professionals, with the objective of evaluating the game's experience and usability;
- Observations and researcher notes to be recorded during all sessions with children, in order to register their behaviors, reactions, and drawings, which later on will provide qualitative insights into how children engage with the game and their emotional responses during the co-design activities;
- Gameplay data, such as the duration of the play and whether the game was completed or abandoned, to be collected for the purpose of correlating these metrics with other measures of ER and usability.

Interviews and co-design sessions will be audio-recorded, anonymized, and transcribed verbatim for accuracy and confidentiality. The self-report questionnaires will be filled out online through the U.Porto platform, except for those completed by children, which will be paper-based.

Additionally, the study will use validated tools in their Portuguese versions to assess clinical and practical metrics, specifically the Emotion Regulation Questionnaire (ERQ) [49] to evaluate ER skills in children, the System Usability Scale (SUS) [50] to measure the overall usability of the game and ensure that it is intuitive and user-friendly, and the User Satisfaction Evaluation Questionnaire (USEQ) [51] to assess participants' satisfaction with the game and their engagement during gameplay.

The presented instruments, along with sociodemographic data to be collected and examples of the creative activities to be performed with children during the sessions are detailed in the annex section.

4.2.4 Ethical Considerations

The project was submitted for approval to the Ethics Committee of the Faculty of Engineering of the University of Porto on November 20. All procedures will strictly adhere to the ethical standards outlined in the 1964 Declaration of Helsinki and its subsequent amendments. The study

will also comply with national data protection laws, namely Law No.58/2019, which governs the processing of personal data in Portugal.

Data collected online will prioritize security, anonymity, and confidentiality. The research team will store data securely on password-protected computers, ensuring that anonymized data is accessible only to the research team and not shared with third parties. Identifying information, such as email addresses, will be stored separately from the research data to protect participants' identities. If any identifying data is accidentally recorded during the study, it will be duly anonymized and never made public.

Upon the conclusion of the study, all personal data will be destroyed, while anonymized research data will be retained for up to six years as part of the FCT-funded project "Development of Game-Based Tools for Mental Health Intervention and Promotion" for scientific research purposes only, and will be securely destroyed by 2029.

4.2.5 Risks and Mitigation Plan

As with the majority of studies, the design of the current approach is subject to risks outside of the researcher's control that could introduce shortcomings during the research process.

One of the primary weaknesses of the designed approach is an insufficient sampling of participants. As explained previously, the co-design involves multiple groups, from end-users to experts, and thus requires different recruitment for each group. Children constitute the main population of the final sample and will be contacted mostly through educational settings, like schools. However, as occurred in previous works on the same topic, schools are often reticent or not open to collaborating with researchers due to time constraints and numerous requests. Furthermore, even with the school's consent, parents may raise concerns regarding their child's participation. Since participants can also withdraw at any point in the co-design process, there is a high risk of insufficient sample size, which could impact the data collection process and later phases. To minimize the likelihood of these circumstances happening, the project was submitted far in advance to the Ethics Committee of the University of Porto for authorization of the co-design methodology, with documents regarding study's description and consents to provide to potential participants. As healthcare professionals, specifically psychologists, work in partnership with LIACC, which is the scope in which this project is inserted, the selection of this group is secured. To mitigate dropouts, the research team will maintain contact with participants, providing support throughout the study and emphasizing the importance of their contributions.

Furthermore, the research might face some barriers regarding technology access for the usability tests. Since some participants may come from lower socioeconomic backgrounds, they might not have access to devices required to play the SG, such as tablets, phones, or computers. On top of that, parents might not authorize the usage of digital technologies due to the young age of their child. The research team does not have the resources to provide devices to all participants, which could further constrain the testing phases. To prevent this limitation, the game will be developed for various types of devices to ensure greater inclusion.

While the research aims to follow a co-design approach with iterative testing phases, the limited timeframe constrains the study to focus on short-term emotional learning outcomes. Although pre- and post-test assessments are included, the time gap between these assessments will be shorter than recommended for projects of this nature. Consequently, the study will not evaluate long-term impacts on children's ER abilities, making it unclear whether the skills gained from playing the SG will translate into real-world behavior changes sustained over time.

Chapter 5

First Phase of Co-Design

The initial plan for the co-design methodology anticipated the active participation of multiple stakeholders, including children, their parents/caregivers, teachers, and psychologists. The involvement of these groups was considered crucial to ensure adequate game design in responding to the needs of the target audience, both from a pedagogical and psychological point of view.

However, in order to implement this approach, it is necessary to first obtain the project's approval from the faculty's Ethics Committee, and, as mentioned in the previous chapter, this request was made in the initial stages of the dissertation, in great advance, in the expectation that the approval would be granted before the co-design began.

Unfortunately, no response was received from the committee, which caused significant delays in the start of the first phase of the co-design. This limitation forced a rethink of the co-design strategy, aiming for other ways to gather feedback and explore design elements without compromising established ethical principles. This chapter describes in detail the new plan for the first phase, delineating the followed procedure and the participants involved, as well as an analysis of the obtained insights.

5.1 Procedure

The central objective for this phase remained unchanged, being to gather practical and relevant information on the theme of ER in children and obtain useful ideas to guide the game design.

Since it was not possible to directly contact the initially planned stakeholders, it was decided for this phase only to include mental health professionals working in collaboration with LIACC. These professionals were contacted by email, where they were introduced to the project and explained the role they would play by participating in this process. In order to be considerate of their time and availability, a structured interview with open questions was created and sent by email, designed to collect insights on the current use of technology in psychological interventions with children, professionals' perceptions of ER difficulties in children, and suggestions and ideas for developing a SG with this focus. The interview had to be longer and with more in-depth questions to guarantee a comprehensive exploration of all relevant topics, as this group of stakeholders

would be the only ones taking part in this phase, and no contact would happen with the game's target audience. The goal was to ensure that the game would still be developed on the basis of good theoretical and practical foundations.

Additionally, participants were also sent a sociodemographic questionnaire to better understand their professional experience. Throughout the data collection process, the anonymity, security, and confidentiality of the responses were guaranteed, following good ethical practices.

5.2 Participants

The participants were exclusively mental health professionals, specifically psychologists, recruited through a convenience sample with the support of LIACC.

The sample consisted of five psychologists, four of whom were female and one male, with ages between 35 and 45 (M = 38.4; SD = 4.10). Additionally, their professional experience ranged from 12 to 22 years (M = 15.6; SD = 4.10), which guarantees a consolidated knowledge of clinical practice and experience. The detailed sociodemographic characteristics of the participants are summarized in Table 5.1.

Table 5.1: Sociodemographic data of the healthcare professionals.

Variable	***n***	***%***	***M* (range)**	***SD***
Gender				
Female	4	80%		
Male	1	20%		
Nationality				
Portuguese	5	100%		
Profession				
Psychologist	5	100%		
Age			38.4 (35-45)	4.10
Years of Professional Experience			15.6 (12-22)	4.10

5.3 Data Analysis

A thematic analysis [52] was conducted on the interviews data to identify the most relevant themes and subthemes. Excerpts of interviews were transcribed verbatim in an anonymized manner and directly quoted in the analysis.

5.4 Results

The results from the data analysis were organized into four major themes: 1) ER in children, 2) Technology in education and clinical interventions, 3) Serious game conceptualization and design, and 4) Strategies for engaging and motivating children in their learning. Each theme was then further explored and divided into subthemes to better understand the insights shared by psychologists.

5.4.1 Theme 1: ER in Children

This theme explores psychologists' perspectives on children's ER difficulties, diving into the types of emotional challenges commonly observed in clinical practice, the strategies typically used to support emotional development, and the consequences of poor ER skills. Furthermore, it also examines the perceived importance of emotional support within school environments.

Common Emotional Difficulties and Associated Contexts

Children's emotional difficulties identified by psychologists translate into trouble in managing basic and primary emotions, as well as identifying one's own emotions and those of others. As participant 4 highlighted, "*the most common emotional difficulties center on managing anger and frustration, namely the difficulty of dealing with 'no' and setting boundaries*".

Furthermore, psychologists noted the prevalence of specific emotions in school-aged children, such as anger, anxiety, frustration, sadness, and fear. In particular, participant 1 explained that "*[...] anxiety is a multidimensional process, involving several dimensions of functioning, and not an emotion*", underscoring its complexity. This psychologist also described children's fears in association "*[...] with injury, health, death, school performance, relationships with peers and supernatural events [...]*".

When questioned about when these difficulties usually arise, psychologists emphasized educational and social contexts, reasoning that transitional phases like entering school amplify anxiety symptoms due to new challenges, namely academic pressure, peer relationships, and performance evaluation. According to participant 5, "*children's emotional difficulties usually arise at times of transition, frustration, or challenge, when they feel insecure or overwhelmed*", adding examples of situations and moments such as "*[...] changes in routine, new places, when they have to wait and share something, when they make mistakes or fail, when they are corrected, when there are difficulties in peer relationships, bullying situations, or at night before bed, and places with high sensory activation (shopping malls, parties)*". Likewise, participant 1 reinforced that "*changes in routine can generate emotional tension and consequently difficulties in easing this tension*".

Therapeutic Approaches to ER in Children

When discussing strategies or exercises usually taught by mental health professionals in clinics, psychologists emphasized the importance of first teaching children to identify and name emotions accurately, and then giving strategies to deal with each one. Tools such as stories, books, and movies were suggested to help children understand and relate to different emotional experiences. Furthermore, role-play, chair-switching games, and dramatized scenarios were also pointed out to practice social and emotional responses.

On top of that, behavioral regulation techniques were a theme recurrently mentioned during interviews, which included breathing exercises, relaxation, mindfulness, and grounding techniques with sensory-based exercises. Participant 1 further added that "*[...] moving away from the situation generating the negative emotion and counting to ten (in the case of anger), the mobilization of strategies for monitoring anger and fear, and measuring their intensity (e.g., meter, anger bells) may also be useful*". To complement the listed techniques, this psychologist also mentioned "*[...] the promotion of conflict resolution and communication strategies [...]*" to help children manage potential problems that arise in interactions with peers.

Moreover, psychologists advised the adjustment of strategies based on developmental level, with a focus on improving study methods for older children as a way to reduce academic stress. As stated by participant 2, "*parental help is also very important, especially for the youngest children*".

Impact of ER Difficulties

When questioned regarding the impact of ER difficulties in school-aged children, all psychologists expressed their harmful impact on the child's functioning, particularly on their learning process, school performance, and peer interactions. Participant 1 believes that "*these difficulties act as a transdiagnostic factor in various psychopathological conditions, tending to act as a risk factor for the emergence and structuring of vulnerabilities in the socio-emotional sphere*".

Regarding the impact on the learning process and school performance, psychologists noted issues with cognitive processes of attention and concentration, and adaptation to school demands. In particular, participant 5 discussed how "*intense emotions, such as anxiety or sadness, can make it difficult to concentrate, reduce motivation and lead to avoidance of new or challenging situations for fear of making mistakes*". This professional also added that "*emotional difficulties interfere with memory and cognitive processing, compromising the retention, organization, and application of information*".

As for peer interactions, it was stated that poorly managed emotions contribute to more social and peer relationship problems, with risks of leading to phenomena such as bullying, in older children. Psychologists also identified difficulties with sharing, waiting turns, and resolving conflicts, which, as a result, tend to increase the number of conflicts and misunderstandings. On top of that, one psychologist [participant 5] noted how "*emotional difficulties associated with the internalization dimension (e.g., anxiety, sadness, fear) can lead to isolation, while those associated with the*

externalization dimension (e.g., aggressiveness or impulsiveness) make it difficult to be accepted by peers". This emphasizes how a lack of emotional skills can lead to misunderstandings and harm coexistence and healthy relationships.

Lastly, another psychologist reinforced that these difficulties can make children less collaborative and more resistant in group or learning settings, with more episodes of oppositional or defiant behaviors.

Emotional Support in School Settings

Given the large role educational settings play in children's everyday lives, psychologists were asked to give their opinions regarding the need for emotional support in schools at different levels of education. All interviews reinforced that it is a very pressing need, as more and more children and adolescents are facing significant emotional challenges.

One psychologist [participant 5] explained that "*school can be a fundamental space for promoting emotion regulation and creating a safe environment, preventing future difficulties [...]*". However, a shortage of psychologists in schools, as well as a lack of resources to adequately support students' emotional needs, were frequently mentioned, which can lead to prioritizing only the most severe cases. In addition, psychologists stated a lack of training for school staff (teachers and non-teaching staff) to deal with children's emotional needs, highlighting a strong need for specific training to be able to provide more adapted and appropriate responses.

Furthermore, participant 3 explained that "*it is essential to implement interventions that focus on socio-emotional skills, whether they are promotional, preventive, or remediative*". Another psychologist [participant 1] added that these interventions should "*focus on self-regulatory processes but involve the main interveners (parents and teachers)*".

5.4.2 Theme 2: Technology in Education and Clinical Interventions

This theme investigates how mental health professionals currently use technology in their practices and their views on the role of digital tools, particularly SGs, in supporting ER training. Additionally, it also addresses the accessibility and perceived benefits of such tools in both clinical and educational settings.

Professionals' Use of Technologies

To understand the current use of technologies for clinical purposes, psychologists were questioned regarding the use of any new technology during consultations or interventions. Around 60% of professionals reported using technology in their interventions, through tools such as apps, YouTube videos, podcasts, tablet-based applications, and interactive/digital games. However, only one professional mentioned using digital games to promote ER, particularly social skills games, whereas the majority (80%, n = 4) have never used games for this purpose.

Furthermore, psychologists were asked about the perceived value of new technologies for educational or therapeutic purposes. There was a consensus in favor of using technology as a complementary tool to traditional methods, with opinions that "*it makes the session more attractive and motivating for children*" [participant 4] and "*[...] it's a more playful way of working on very important topics without the child realizing it*" [participant 2]. Another psychologist [participant 1] added that "*technology, when used consciously and intentionally, is a privileged resource in both educational and therapeutic contexts*".

Lastly, one professional [participant 5] explained that these tools must be well-structured and take into account child development and individual differences, including age and comorbidities. This psychologist also discusses "*the need to balance sensory-motor experiences in the real world*" when using technologies as a resource for educational or therapeutic purposes.

Perspectives on the Use of SGs for ER Training

After understanding their opinions regarding new technologies, psychologists were interviewed regarding their familiarity with SGs. All professionals reported knowing about the concept of SGs, with one of them actively involved in guiding the development of an SG to promote ER skills in young people in residential care. One psychologist [participant 5] noted SGs as "*[...] a valuable tool for promoting meaningful learning, especially if they are integrated with approaches that involve the body and sensory experience*". Despite SGs' positive reception, another professional highlighted the limited availability of such tools on the Portuguese market, which, as a result, restricts their usage in interventions.

The interviews then moved on to schools' and families' access to technological tools, such as SGs, for children, with psychologists expressing broad support. One professional [participant 3] noted various advantages, expressing that "*[...] it promotes the involvement of families in a serious process of self-regulatory promotion, they don't have to go to a specific place, they can do it whenever they want and for as long as they want*". Equally, another psychologist [participant 4] added that these tools "*[...] help train skills and facilitate adherence and consolidation of therapeutic gains*". During interviews, one psychologist [participant 5] warned of the importance of guiding teachers and families towards conscious and regulated use, making it clear that technology alone is not a quick fix. This professional further added that these tools should still promote "*[...] interaction between the child and the therapist, and at home with parents*".

When discussing the development of an SG, particularly for training ER skills in children, professionals demonstrated great support for their application in clinical contexts, with one [participant 4] even adding that "*this is a current need that professionals, particularly psychologists, are facing*". This interview highlighted a current demand for versatile tools specific to work on socioemotional skills. Likewise, another psychologist [participant 1] reasoned that SGs for the promotion of ER in children "*are a very interesting alternative [...], due to their appealing nature and the multiplicity of scenarios and strategies they allow for exploration*". Additionally, it was added that if well-designed, these tools can help children recognize and modulate emotions.

5.4.3 Theme 3: SG Conceptualization and Design

In this theme, psychologists provide conceptual input for designing a SG focused on ER for school-aged children. It includes their suggestions on suitable scenarios, storylines, character types, and game mechanics that could effectively engage children and support emotional learning in a developmentally appropriate way.

Scenarios and Storylines

Regarding gathering conceptual ideas for the game design, professionals were questioned about adequate environments or contexts, as well as good scenarios and storylines for the game. Psychologists strongly suggested including and diversifying real-life settings that children experience regularly to help them relate emotionally and cognitively. As one psychologist [participant 1] noted, contexts "*[...] such as home, school and the playground [...] may be appropriate*". Additionally, extracurricular settings (e.g., sports club, dance classes), going to the supermarket, or birthday parties were also mentioned as contexts often present in children's everyday lives.

While scenarios similar to the real world were greatly emphasized, fantasy and imaginative settings were also noted as highly motivating and engaging, arousing curiosity and imagination. In particular, "*scenarios such as adventures in magical worlds, quests to save characters, solving mysteries/puzzles, and conflicts/dilemmas [...]*" [participant 1] were considered interesting and suitable for the targeted age group.

Another common idea among psychologists is that these scenarios should include emotional challenges or conflicts, "*[...] involving characters with different emotional states who need help to regulate themselves*" [participant 5].

Furthermore, values and social interactions were also discussed in one interview, reinforcing that stories should promote positive values, such as responsibility and generosity, and involve relationships with peers and adults.

Characters

All professionals proposed realistic characters, so that children feel more connected when they see themselves reflected in the characters' appearance and experiences. One psychologist also suggested the inclusion of superhero-type characters alongside realistic ones, to whom children can relate.

While only mentioned in one interview, integrating humorous traits into characters was also an idea to make the game more engaging.

Overall, interviews indicate that when creating characters for the game, the focus should be on relatability to ensure broad emotional resonance in children, and thus greater engagement with the digital intervention.

Game Activities and Mechanics

Psychologists agreed that game activities should revolve around emotional dilemmas or conflicts where the child must identify and manage emotional responses. As one psychologist [participant 3] stated, "*[...] the dramatization of real situations (that happen in everyday life) where it is necessary to use different emotion regulation skills (some more appropriate and effective than others)*" are adequate activities to promote these competencies in school-aged children. Furthermore, this professional added that real tasks and activities such as "*playing ball, taking a test, losing their bag, getting angry with a colleague*" help develop the ability to negotiate and resolve conflicts independently.

At the same time, decision-making and strategy selection were some of the mechanics suggested to resolve the emotional dilemmas. These were described as "*activities that allow the child to acquire some control over the decision-making process of the game [...]*" [participant 4], with multiple response options, including both adaptive and non-adaptive strategies to encourage critical thinking. As one psychologist [participant 5] suggested, these choices can be as simple as "*[...] deciding between 'ignoring the comment' or 'expressing how they feel', which can help them reflect on the consequences of their emotional actions*". Furthermore, this psychologist gave an example of an activity in which the child can choose from different strategies to deal with a specific emotion: "*If the character feels frustrated, they must choose between options such as 'going for a walk', 'talking to someone', or 'taking a break'*". Overall, psychologists reinforced the inclusion of positive solutions, with deep breathing, muscle relaxation, or guided meditation activities, so that children experience techniques they can use in the real world to calm down. "*Sorting cards or images that represent various emotions and situations (e.g., a child can choose between 'joy' and 'sadness' when the character wins a race or loses a game)*" [participant 5] were also activities recommended in helping develop emotional recognition skills and understanding of context.

However, before learning to apply the best strategies, it was suggested that children learn to identify the correct emotion. Furthermore, one psychologist advised on some kind of in-game structure, with an initial phase (e.g., tutorial system) that makes it possible to teach, train in a second phase, apply skills with hints/help in a later phase, and enable a more autonomous decision-making process in a final phase.

In general, these perspectives suggest that scenarios can include branching storylines where the child must choose from multiple strategies on how the character reacts emotionally and understand their effects.

Platform Choice

Tablets are the most commonly suggested platform for school-aged children, considering "*[...] the size of the screen and the visibility it provides [...]*" [participant 1], as well as "*[...] better image quality and more controlled everyday use*" [participant 4].

Psychologists also suggested PCs, as they allow "*[...] greater complexity in interactions and learning*" [participant 5], thus enabling more complex gameplay. Phones are also seen as a possible platform, due to their convenience for use in various settings.

5.4.4 Theme 4: Strategies for Engaging and Motivating Children in Their Learning

This final theme presents professionals' recommendations for enhancing children's motivation and engagement while promoting learning. It discusses feedback systems, reward mechanisms, accessibility and inclusivity considerations, and the role of parents in facilitating emotional reflection and strategy transfer from the game to real-life situations.

Feedback, Motivation and Rewards

Psychologists were asked the best way to give children feedback on their training in ER strategies. Considering the developmental phase of school-aged children, immediate feedback was emphasized as extremely important, and can consist of "*[...] visual and sound changes in the game environment*" [participant 5] to help reinforce learning. One professional explained that "*[...] the proximity of time in the administration of reinforcement is particularly relevant for younger children*" [participant 1], denoting that the child should be immediately provided with information about their performance after a given situation has been presented. This psychologist further added that this feedback could take the form of constructive guidance about the selected ER strategy, meaning that if the child mobilizes a maladaptive strategy, the game should present "*[...] appropriate emotion regulation strategies to deal with the problematic situation they have been confronted with*". One other professional suggested the inclusion of summary screens or short videos at the end of a level to reinforce key emotional learning.

Another aspect to consider is ensuring the game's objectives are achievable and motivating for the targeted developmental ages. As discussed in the section about scenarios and storylines, resolving emotional dilemmas or making decisions about emotional responses are realistic and age-appropriate challenges that keep children engaged and drive curiosity. As one psychologist [participant 5] stated, "*the challenges should gradually become more difficult, with tasks that require more emotional skills*". Likewise, other psychologists reinforced this perspective, highlighting the importance of having a progressive difficulty system to keep children engaged while ensuring success in early levels.

Various types of rewards were suggested to complement the above-mentioned motivation strategies, including tangible digital rewards, social elements, or unlockables. Tangible rewards were the most recommended during interviews and can consist of symbols such as stars, medals, a safe with coins, trophies, or points. Furthermore, psychologists noted that social rewards such as leaderboards or ratings are very motivating, as "*school children like to show off their achievements*" [participant 3], especially among their friends. Lastly, unlocking subsequent levels, new stories, or missions were also suggested as effective in motivating through progression.

On a last note, psychologists discussed how to balance challenge and achievability, suggesting the inclusion of adaptive difficulty. One professional [participant 5] explained that this consists of "*creating a progression system that adapts to the child's level, with adjustable challenges and moments of support when necessary*". This professional further added that children should be given "*[...] the opportunity to change their decision or find new solutions*". At the same time, another psychologist advertised for organizing gameplay in progressive emotion tiers, starting "*[...] with simpler emotions (such as sadness and joy) and then moving on to more complex ones*" [participant 2].

Accessibility and Inclusivity

During interviews, one psychologist [participant 1] emphasized the need to ensure accessibility and inclusivity for children with different emotional and cognitive needs, stating: "*It's important to make sure that the game can be used by children with functional differences, such as children with vision or hearing difficulties.*"

Parental Assistance

Given the developmental phase of school-aged children, the role of parents may be something to consider in the game design. Psychologists argued that younger children may struggle to use devices on their own, requiring active participation of adults, particularly parents and teachers. However, one professional [participant 3] made clear that "*it's children who decide what their parents respond to and do in a given situation*", reinforcing reflection and understanding.

According to the psychologists, it is important to promote dialogues and reflection, encouraging post-game conversations between children and parents to deepen understanding. "*For school-aged children, parents can play a more active role in helping to reflect on the decisions made in the game. They can be encouraged to discuss with children the emotional situations that arise during the game, promoting dialogues about what it means to regulate emotions and how to apply regulation strategies in everyday life.*" [participant 5]. On the same note, another psychologist [participant 1] suggested that "*[...] some of the games could be configured as a co-construction exercise*", to allow for the aforementioned parent-children interactions.

Overall, interviews emphasized the importance of parental assistance during gameplay, either to help children understand the scenarios, or having co-play elements or a parent section with educational content for parents to support transfer of learning to daily routines.

5.5 Conclusions

The first phase of the co-design process faced serious setbacks, namely the delay in its start and, more significantly, the failure to obtain the necessary approval from the Ethics Committee, which made it impossible to carry out the original plan. Although this limitation had been anticipated and

discussed in the previous chapter, its occurrence led to significant changes to the initially defined methodology.

Despite these obstacles, a considerable effort was made to ensure that the co-design process could still be conducted, given its central role in the game's development. Therefore, the final decision was to only involve health care professionals who already worked in collaboration with LIACC.

Even with a reduced number of participants, the collected feedback was very detailed, covering each topic in-depth and showing the psychologists' practical experiences, allowing for the gathering of concrete ideas that greatly influenced the game's design. From the thematic analysis, key concepts emerged that were agreed upon by the professionals, such as the importance of narratives that are close to children's everyday lives, the introduction of emotional challenges with multiple response options, and the use of realistic characters that children can relate to. This new knowledge left no doubt as to what the game's concept should be and the type of mechanics to be implemented, highlighting the great impact of this phase on the project's course.

Each design feature chosen for the game was directly informed by the qualitative results of the interviews' thematic analysis, thus ensuring that the game not only promotes children's emotional development in a fun and engaging way but also remains aligned with evidence-based and pedagogically grounded practices. Table 5.2 identifies the correspondence between each design feature and the themes and sub-themes.

Table 5.2: Design features resulting from the analysis of the first co-design phase

Design Feature	**Associated theme(s) and subtheme(s)**
Levels with mini-games to teach emotions and ER strategies	*Theme 1*: ER in Children > Therapeutic Approaches to ER in Children *Theme 3*: SG Conceptualization and Design > Game Activities and Mechanics
Narrative structure based on real-life situations	*Theme 1*: ER in Children > Common Emotional Difficulties and Associated Contexts *Theme 3*: SG Conceptualization and Design > Scenarios and Storylines *Theme 3*: SG Conceptualization and Design > Characters
Progressive unlocking of levels	*Theme 4*: Strategies for Engaging and Motivating Children in Their Learning > Feedback, Motivation and Rewards
Multiple-choice / decision-making mechanics	*Theme 3*: SG Conceptualization and Design > Game Activities and Mechanics
Sticker collection as a reward system	*Theme 4*: Strategies for Engaging and Motivating Children in Their Learning > Feedback, Motivation and Rewards
Visual feedback	*Theme 4*: Strategies for Engaging and Motivating Children in Their Learning > Feedback, Motivation and Rewards *Theme 4*: Strategies for Engaging and Motivating Children in Their Learning > Accessibility and Inclusivity
Inclusion of audio as a complement to text	*Theme 4*: Strategies for Engaging and Motivating Children in Their Learning > Accessibility and Inclusivity *Theme 4*: Strategies for Engaging and Motivating Children in Their Learning > Parental Assistance
Tablet as the chosen platform	*Theme 3*: SG Conceptualization and Design > Platform Choice

Chapter 6

EmotiToon

This chapter presents a description of *EmotiToon*, detailing the game's design decisions derived from the conceptual phase of the co-design.

6.1 Game Overview

6.1.1 Game Concept and Objectives

EmotiToon is a narrative-based and interactive game where players help the main character face emotional dilemmas in real-life scenarios through stories told in the form of dialogue. Throughout this journey, players will also play themed mini-games and collect virtual stickers for a personalized notebook. The name *EmotiToon* originates from the combination of the words emotion and cartoon, perfectly reflecting the game's visual style, inspired by cartoons, and its central objective, to help children recognize, understand, and regulate their emotions. The game was designed for school-aged children between the ages of 6 to 9 years old, to be used in both clinical and non-clinical settings, such as at home or in school.

The world of *EmotiToon* is structured around six real-life scenarios present in children's everyday lives, such as at-home moments, evaluation periods, or disagreements between friends. Each scenario corresponds to a level that tells a short story with interactive dialogues between characters, requiring decision-making to solve challenging emotional situations (Figure 6.1). Throughout each level, children are encouraged to reflect on the depicted emotions and to choose appropriate ER strategies. While unfolding the story, children will find simple and fun mini-games related to the situation and emotion addressed. These short games are designed to promote attention, memory, and emotional control, reinforcing the theme of the episode. By solving the challenges correctly or finishing a level, children earn stickers illustrating the emotions and strategies they have learned, which can later be dragged and dropped into an interactive notebook to give a sense of progression and completion.

Although the game was primarily developed for mobile devices, specifically tablets, it was published on a web-based platform to enable compatibility across different devices and operating systems.

Figure 6.1: EmotiToon - Example of a decision moment and reward attribution

6.1.2 Theoretical Foundations

Given its main educational objective and the relevance of correctly teaching emotions and ER strategies, *EmotiToon* was created based on solid scientific references in the field of psychology of emotions and child development. The emotions represented in the game were selected based on the work of the renowned psychologist Paul Ekman, one of the world's leading authorities on the study of emotions. Ekman is known for his research into universal facial expressions and has identified a set of basic emotions, expressed and recognized in all cultures, and a set of more complex ones, involving social contexts and cognitive interpretations [53, 54]. In *EmotiToon*, the basic chosen emotions were anger, fear, sadness, disgust, and joy, and the complex emotions were anxiety, embarrassment, and jealousy. These emotions also served as the basis for the famous animation films Inside Out (2015) and Inside Out 2 (2024), which were a huge success worldwide in the way they helped children, and even adults, understand the inner workings of emotions. Table 6.1 summarizes the targeted emotions along with their definitions and common triggers, associated physical sensations, and in-game representation. These concepts were synthesized from the literature [55, 56, 57] and served as a theoretical guide for the depiction and explanation of each emotion in the game.

In addition, the game also teaches children how to deal with emotions in a healthy way, applying strategies defined in Gross's model for ER [4]. These strategies are integrated into *EmotiToon's* narrative decisions and allow children to experiment with different ways of managing emotions and discover which are most effective and appropriate for each situation. The depicted strategies are: situation selection (avoidance), situation modification (direct request), attentional deployment (distraction and rumination), cognitive change (cognitive reappraisal and acceptance), and response modulation (expressive suppression and physiological intervention).

Table 6.1: Explanation and sensations of each emotion included in the game

Emotion	**Explanation**	**Sensation**	**In-Game Representation**
Fear	Arises with the threat of harm, either physical, emotional, or psychological, real or imagined. Keeps us safe as it mobilizes us to cope with potential danger.	Feeling cold and shortness of breath. Sweating and trembling or tightening of muscles in the arms and legs.	Darkness in the bedroom and fear of imaginary monsters.
Disgust	Feeling of aversion towards something offensive, and perceived with our physical senses, by the actions or appearances of people, and even by ideas.	Revulsion in the mouth, throat, and/or stomach, and nausea, or physical repulsion (i.e., vomiting).	Spoiled food and unfamiliar dishes during mealtime.
Joy	Arises from connection or sensory pleasure.	Feeling light/uplifted, energetic, buzzing or tingling, warm, or grounded.	Feeling proud after overcoming a challenge or being happy for a sibling's accomplishment.
Anger	Arises when we are blocked from pursuing a goal and/or treated unfairly	Feeling hot, sweating, muscle tension, and clenching one's jaw and/or fists.	A friend steals the ball during playtime, creating a sense of injustice.
Sadness	Results from the loss of someone or something important Signals a need to receive help or comfort.	Tightness of the chest, heaviness of the limbs, stinging in the throat, and/or watery eyes.	A friend refuses to talk after a conflict, creating emotional disconnection.
Shame	Arises from a deep sense of exposure, inadequacy, and worthlessness Feelings of being observed, judged, or found lacking by others	Averted gaze, lowered head and slumped posture, blushing, cognitive shock, and hyper-awareness of the self.	Reading aloud in front of the class.
Jealousy	Arises from a fear of being replaced, losing emotional priority, or when someone else is praised or admired, challenging one's sense of worth or equality.	Increased heart rate, stomach discomfort, tense muscles or clenched fists, changes in breathing, feeling hot, tears, fidgeting.	Feeling left out when the parents give attention to a younger sibling.
Anxiety	Arises from perceived threats or anticipated negative events that may never actually occur	Increased heart rate, rapid breathing, sweating, nausea, trembling, tense muscles.	Worry and tension before a school test.

6.1.3 Game Flow

EmotiToon is carefully designed to guide children through an interactive emotional journey, with a sequence of levels. Firstly, the game starts with a brief introduction of its objectives and what the player can do, inviting them to choose their character (a boy or a girl) and their name. This step is optional and can be skipped, meaning that a default character and name will be assigned. Afterwards, the player can either select a level or explore their notebook. The levels are organized in two main scenarios (house and school), each of which is subdivided into more specific scenarios. The child can play the levels in sequence or revisit previous ones, promoting a review and deepening of emotional concepts. The notebook allows the player to place their collected stickers in the correct slots, as well as answer simple self-reflection questions.

The described game flow for *EmotiToon* is illustrated in Figure 6.2.

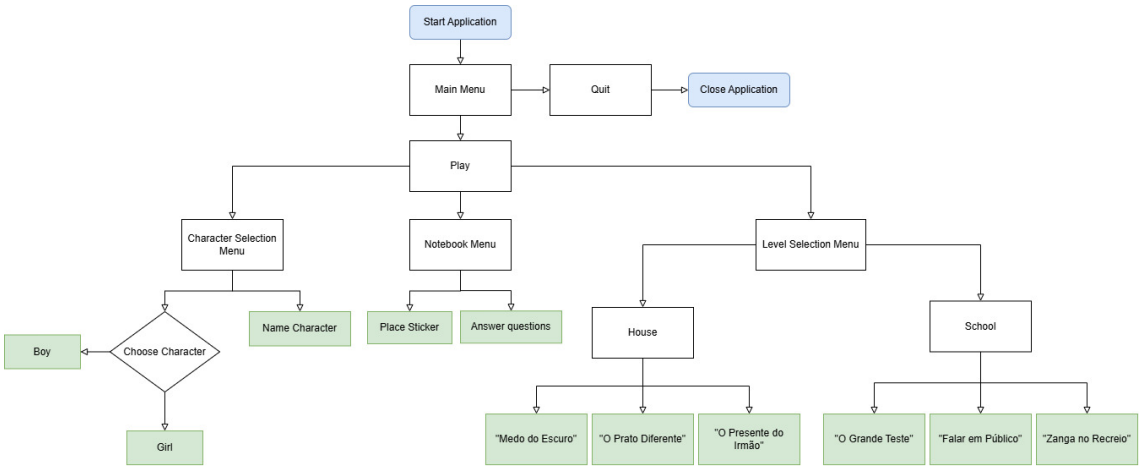


Figure 6.2: Game flow chart.

6.1.4 Game Architecture

The architecture of *EmotiToon* was developed to support its educational and emotional development objectives through a modular, scene-based structure built entirely in the Unity game engine. Through Unity's component-driven and event-driven design paradigms, the system is organized around core elements such as Scenes, GameObjects, Scripts, and Prefabs, enabling a scalable and maintainable structure suitable for iterative development.

The game is divided into multiple Unity Scenes, each corresponding to a distinct functional area of the application, allowing for clean transitions between gameplay stages and facilitating efficient memory management. The main scenes include:

- **Main Menu Scene**: Serves as the entry point to the game, responsible for initializing and loading all saved user data, including game progress, selected character, and collected stickers.

- **Levels Menu Scene**: Enables the player to select levels, access the sticker notebook, and choose between available characters.
- **Level Scene**: Each emotional scenario is encapsulated in its own scene, allowing all relevant content, such as dialogues, minigames, rewards, and audio, to be self-contained. This modularity supports the straightforward addition of new emotional scenarios without disrupting existing game logic.

The core game logic is handled by C# scripts attached to GameObjects, which make use of Unity's event system to manage real-time interactions, user input, and feedback delivery. Key scripts include:

- `GameInitializer.cs`: Loads saved player data including sticker collection, character selection, and overall game state.
- `LevelsMenu.cs`: Manages level states (locked, unlocked, completed) and tracks the currently selected character.
- `DialogManager.cs`: Oversees all dialogue-related functionality within levels, including line sequencing and tag parsing, and controls the narrative flow.
- `MinigameManager.cs`: Coordinates the initialization and completion of minigame interactions embedded in each level.
- `NotebookManager.cs`: Maintains the sticker notebook state, organizing stickers by page and tracking which have been collected, placed, or remain pending.
- `RewardManager.cs`: Handles the sticker reward system, maintaining an internal list of all available stickers and distributing them based on gameplay outcomes.
- `AudioManager.cs`: Manages voiceover playback to ensure clear and non-overlapping audio feedback.

Furthermore, each minigame also includes a dedicated script responsible for its specific logic, enabling modular development and reusability.

The design of this architecture took into consideration content reuse and simplification for future expansions, through the creation of core Prefabs:

- **Dialogue UI Prefab**: Encapsulates all elements related to dialogue presentation and interaction.
- **Managers Prefab**: Aggregates essential controllers (e.g., dialogue, minigame, and reward managers) to reduce redundancy across level scenes.
- **Puzzle Prefab**: Standardized across all levels, requiring only changes to the puzzle image asset to represent different emotional situations.

All game data is stored locally using Unity's PlayerPrefs system, which maintains information such as game progression, sticker collection, and selected character to ensure that players can seamlessly resume gameplay between sessions.

Moreover, Unity's EventSystem manages user input, accommodating both mouse and touch-based interaction, while the Canvas UI system is employed for rendering all user interface components, including characters, dialogue boxes, buttons, and backgrounds.

This modular and extensible architecture is particularly advantageous for the future development of EmotiToon, where new emotional scenarios, characters, and sticker rewards can be integrated efficiently by creating new scenes and reusing existing prefabs and logic scripts. This design not only enhances maintainability and scalability but also aligns with the educational goal of gradually expanding the game's emotional learning content to address a wider range of situations and developmental needs. The overall system structure is illustrated in Figure 6.3, which provides a visual representation of the core scenes, scripts, and prefabs involved in the game's modular design.

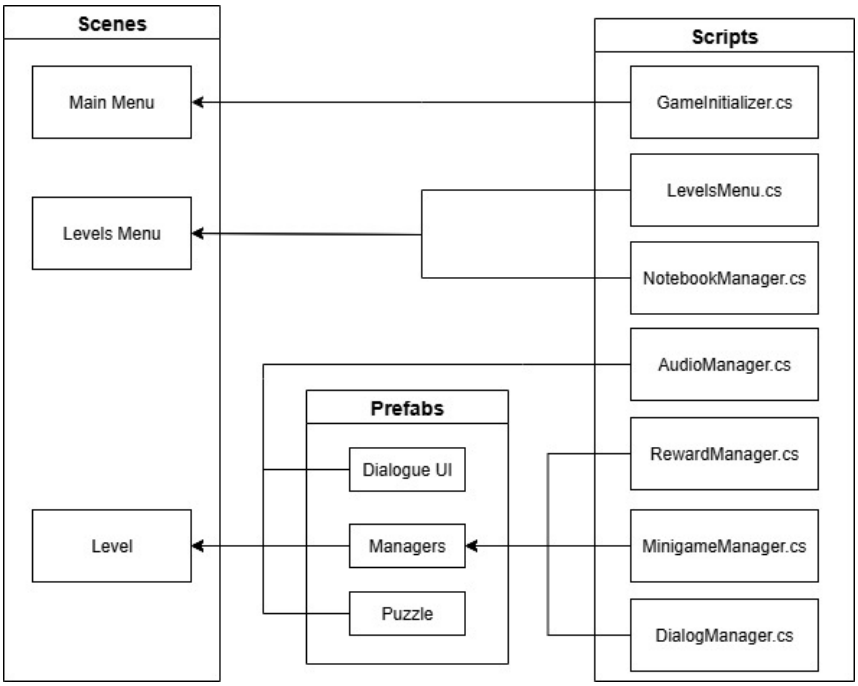


Figure 6.3: System Architecture of *EmotiToon*, illustrating the scene structure, core scripts, and reusable prefabs

6.2 Levels

EmotiToon is structured around a sequential unlocking system of six levels, meaning that at the start, only one level, '*Medo do Escuro*', is available to play, and the next levels will be unlocked once the previous one has been completed. Each level is designed to teach at least one specific

emotion (basic or complex) and at least one ER strategy, contextualizing it in a situation from children's daily lives that makes it easier for them to identify and understand.

Furthermore, all levels follow a narrative and interactive structure, with the following main elements:

- Narrative introduction led by the narrator who locates the story and introduces the emotional context;
- Simple advancement of the dialogue with a tap or click anywhere on the screen;
- Mini-game '*Puzzle das Emoções*', where the child identifies the depicted emotion in the character and the puzzle, by rearranging the pieces in a specific order to complete the image;
- Dialogue with emotional choices, in which the child selects between at least two options (one positive and one negative) that represent ER strategies. If the child chooses an inappropriate strategy, clear feedback is provided through animations and facial expressions, as well as the characters or narrator's speech. The situation is then re-presented, allowing the child to correct their choice;
- At least one additional mini-game thematically related to the correct ER strategy;
- Collectible stickers awarded for each challenge overcome, such as completing a mini-game or finishing the level. The narrator always explains the sticker's meaning, helping consolidate the learning.

Additionally, all levels include three recurring characters:

- The main character chosen by the child;
- The narrator, who guides the narrative and provides feedback and explanations;
- A secondary character who interacts directly with the main character in each scenario, giving rise to the presented emotional dilemma.

Given that all levels' dialogues were written in Portuguese, the diagrams that represent them will also be in that language, maintaining consistency with the context in which the game was developed.

In the following sections, the levels composing *EmotiToon* are described in detail, highlighting the emotional objectives of each one, the storyline, and the ER strategies applied.

6.2.1 Level 1: Medo do Escuro

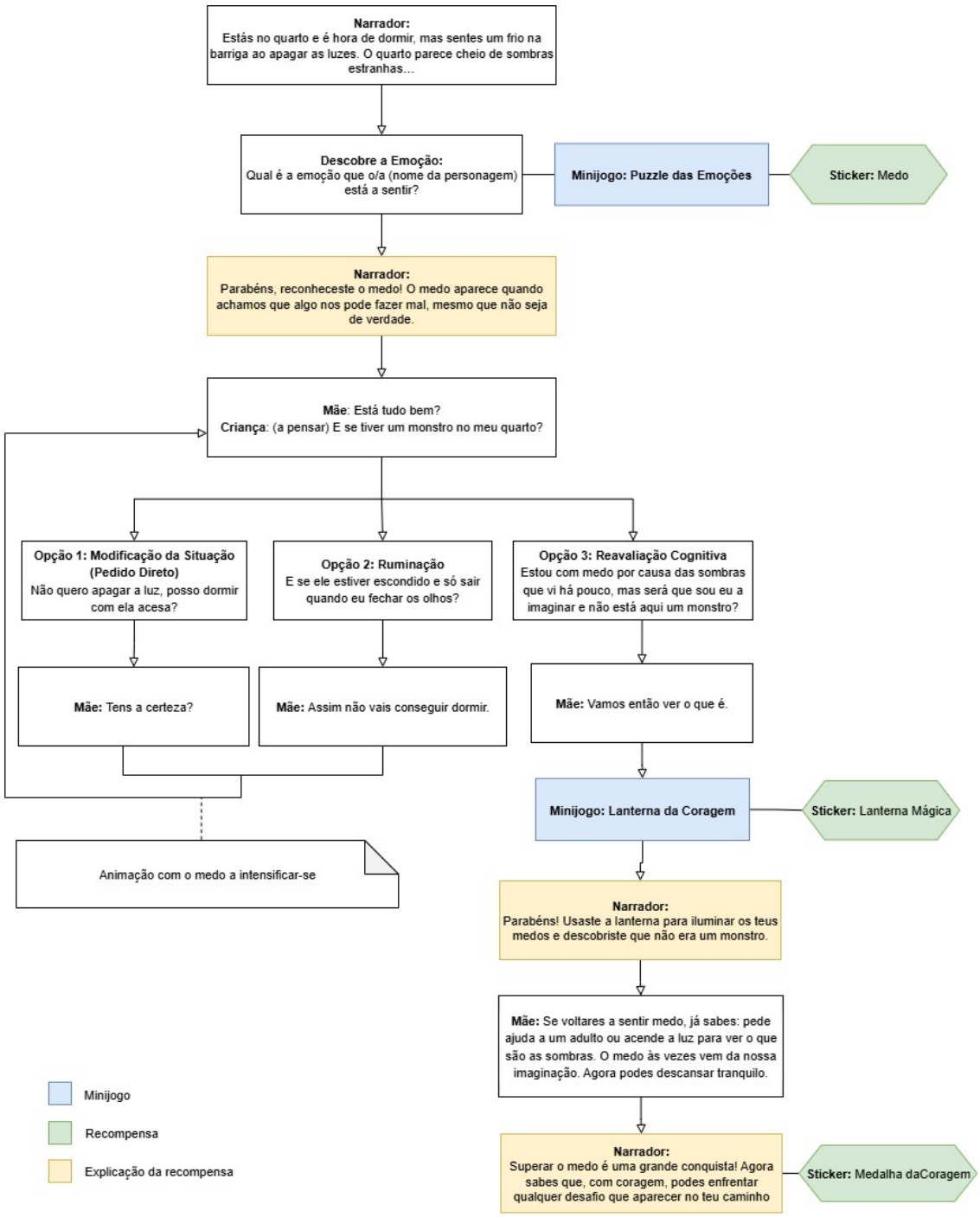


Figure 6.4: Game flow chart - Level 1

Being the first level of the game, '*Medo do Escuro*' (Figure 6.4) serves as an introductory level to the game mechanics, while addressing the basic emotion of fear. The story takes place at night, in the main character's bedroom (Figure 6.5). When the lights are on, the room appears to be a perfectly normal child's bedroom, instantly familiar and comforting. However, when the lights go off, the environment transforms with the entire screen becoming black, and pairs of colorful, blinking eyes appearing in the background, representing imaginary monsters hidden in the shadows. This visual contrast depicts the shift from a familiar space to a threatening one when fear takes over.

(a) Story contextualization (b) Child's dialogue line

Figure 6.5: Level 1 storyline

The first interaction requires the child to identify the emotion that the main character is feeling by playing the mini-game '*Puzzle da Emoção*' (Figure 6.6).

Figure 6.6: Mini-game '*Puzzle das Emoções*' to recognize the emotion of fear

The story then progresses with the mother entering the scene and tries to help the character deal with this fear. At this point, the child is given three possible strategies, with only one being an adaptive ER strategy, corresponding to Cognitive Reappraisal.

When the correct strategy is chosen, the level continues with the mini-game '*Lanterna da Coragem*' (Figure 6.7), where the child must use a flashlight, controlled by touch or mouse movement,

to move the beam of light across the screen and explore the darkened room, gradually revealing that the imagined "monsters" are actually harmless objects like furniture. When all hidden objects are fully illuminated, the room is lit up again and the main character feels safe, realizing that there was nothing to fear. This mini-game reinforces the idea that fear often comes from imagination and encourages the child to look at the situation differently.

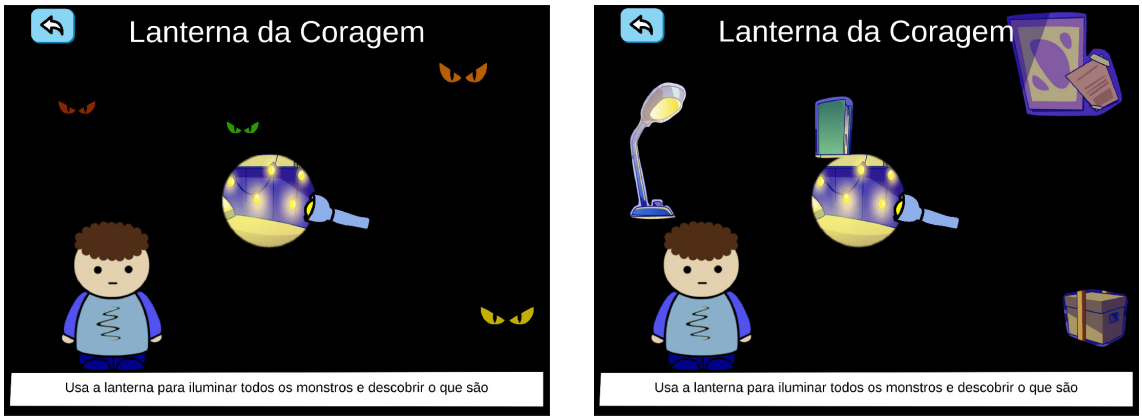


Figure 6.7: Mini-game '*Lanterna da Coragem*'

The level ends with a reassuring message from the mother, encouraging the child to feel safe and in control, and marking the successful conclusion of the first emotional challenge in the game.

6.2.2 Level 2: O Prato Diferente

The second level, '*O Prato Diferente*' (Figure 6.8), focuses on the emotion of disgust and presents a slight increase in narrative complexity compared to the first level. The story takes place during dinner time in a dinning room, when the character is served an unfamiliar dish that appears visibly spoiled, with unusual colors and questionable texture, prompting an instinctive reaction of discomfort and nausea (Figure 6.9a). These visual cues are designed to help the child recognize through observation that the food is not safe to eat.

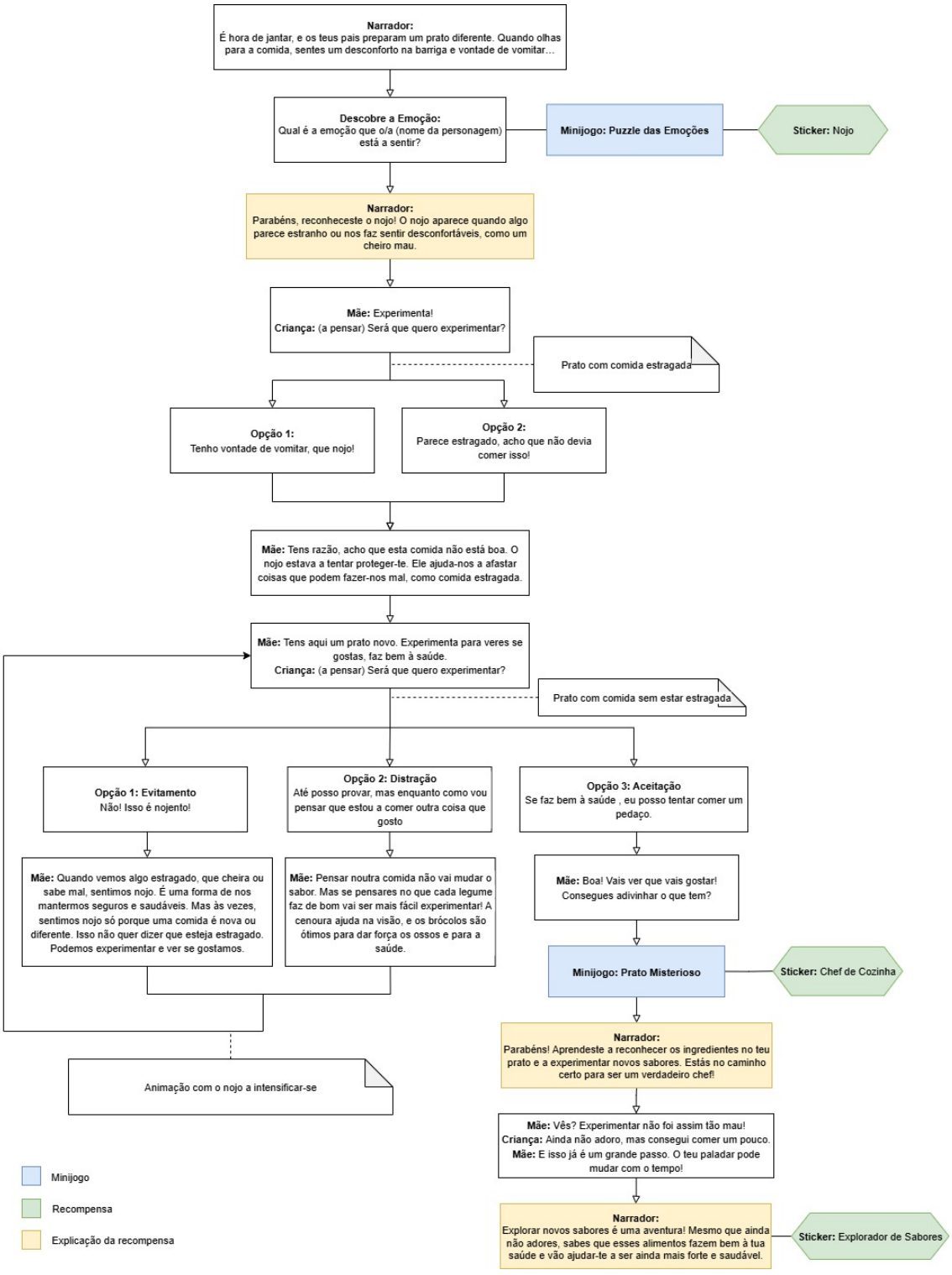


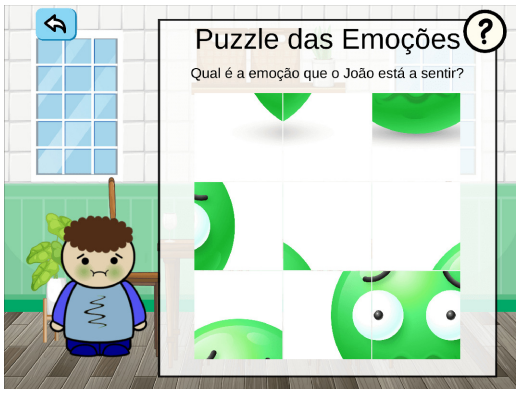
Figure 6.8: Game flow chart - Level 2

(a) Plate with spoiled food

(b) Plate with healthy food

Figure 6.9: Level 2 storyline

As in all levels, this leads to the first task of identifying the emotion through the puzzle mini-game (Figure 6.10).



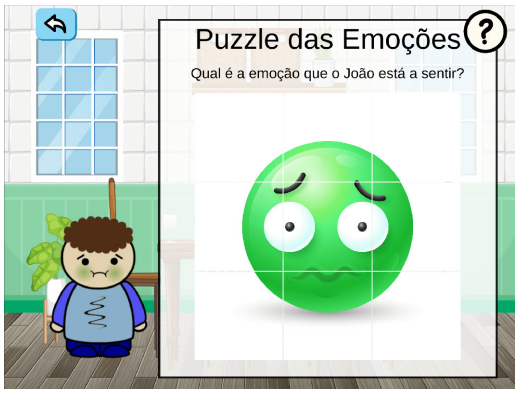


Figure 6.10: Mini-game '*Puzzle das Emoções*' to recognize the emotion of disgust

Once disgust is recognized, the mother encourages the child to try the food. The goal here is to teach that disgust is a natural protective mechanism, alerting us against potential harm, such as rotten or unsafe food. Afterwards, a new plate is introduced, which is safe to eat but unfamiliar, reframing disgust in the context of trying new foods (Figure 6.9b). The child is now challenged to explore this feeling by playing the mini-game '*Prato Misterioso*', where a plate with hidden food items is shown (Figure 6.11). The objective is to drag and place each visible ingredient around the plate in its proper spot, based on shape, stimulating visual discrimination, focus and open-mindedness to try new things. This mini-game reinforces the idea that not all unfamiliar foods are bad, encouraging the child to overcome initial hesitation through playful interactions with the new food.

The level concludes with a conversation in which the mother praises the child's willingness to explore something new.

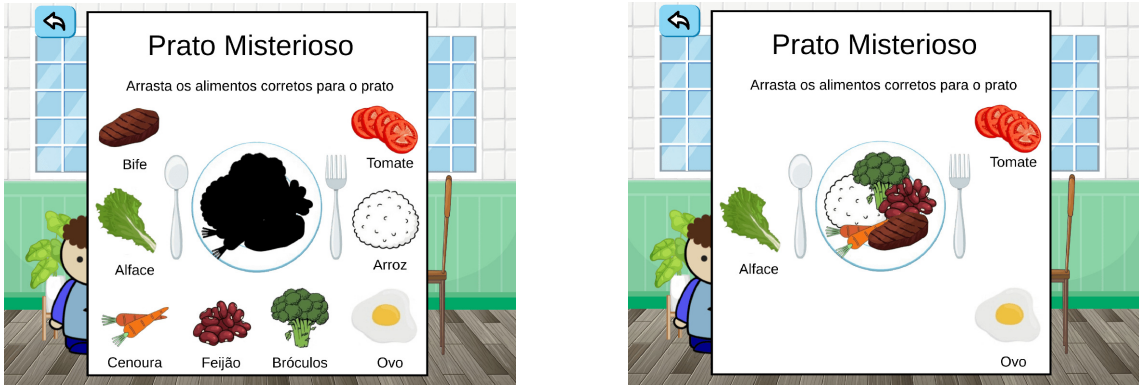


Figure 6.11: Mini-game '*Prato Misterioso*'

6.2.3 Level 3: O Presente do Irmão

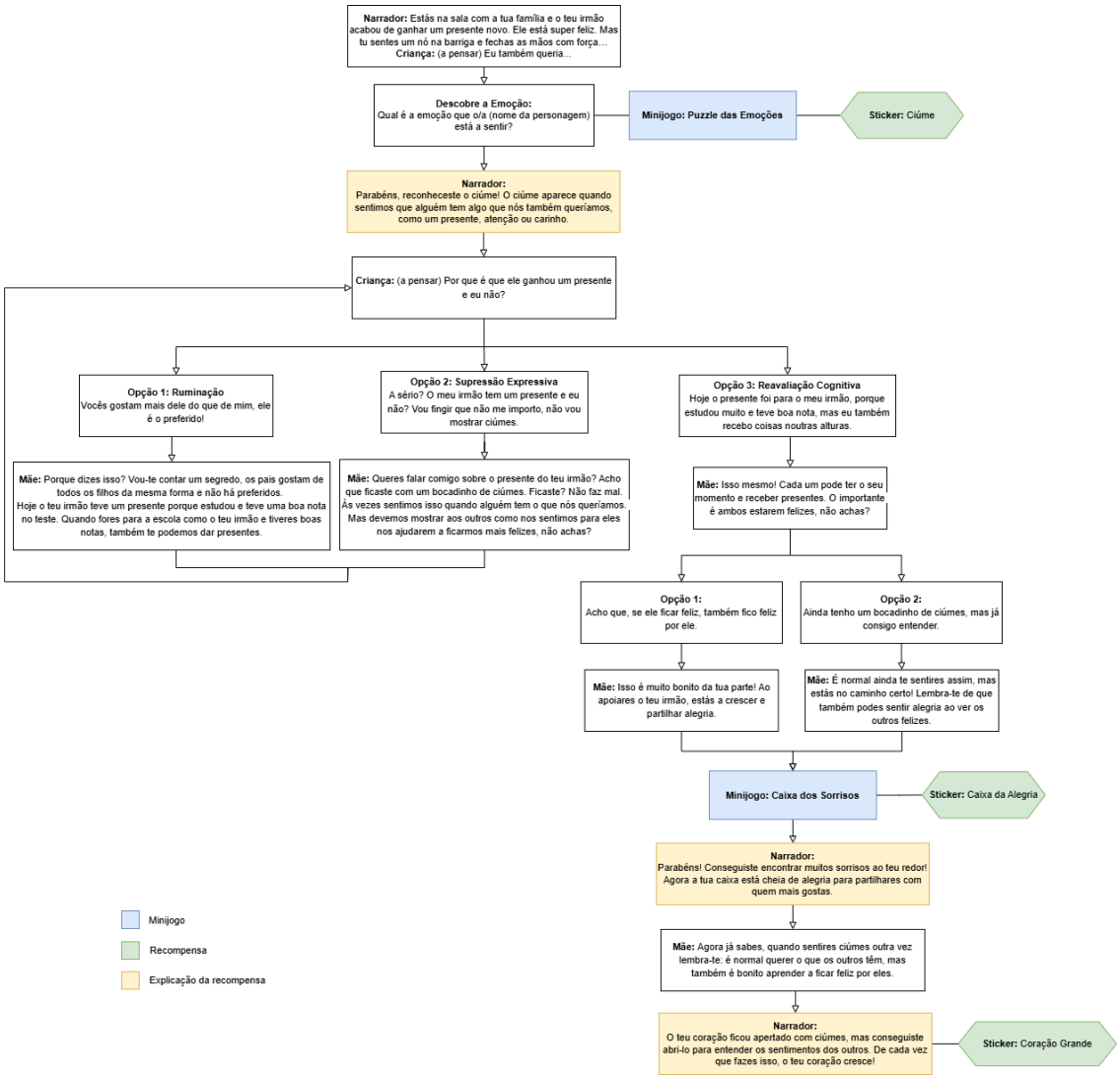


Figure 6.12: Game flow chart - Level 3

The third level '*O Presente do Irmão*' (Figure 6.12) increases the emotional complexity by addressing the emotions of jealousy and joy in the same story, given that these emotions are often interconnected in social situations, especially among children. Additionally, the pairing of joy after jealousy can help the development of empathy. The storyline takes place in the living room, where the main character observes his brother receiving a gift from their mother (Figure 6.13), portraying a common situation in which a child feels excluded or belittled when they see another child receiving attention, praise or success.

(a) Story contextualization (b) Child's dialogue line

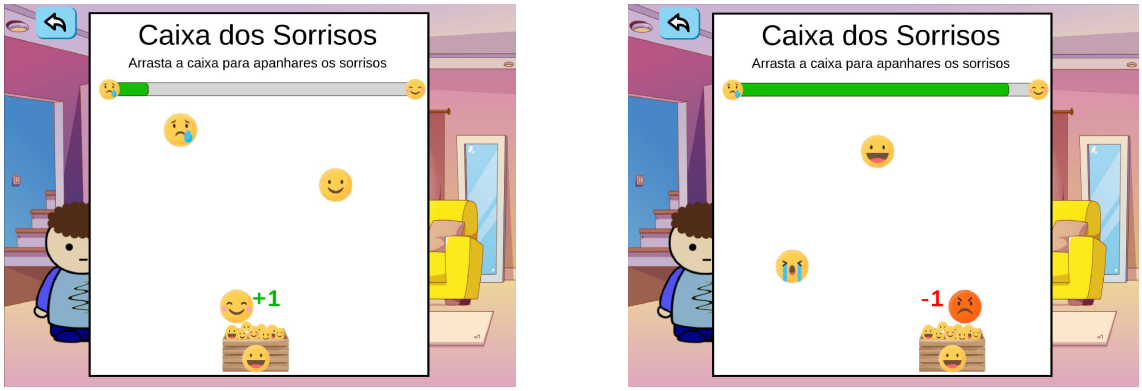
Figure 6.13: Level 3 storyline

After recognizing jealousy to be the depicted emotion (Figure 6.14), the child is presented with multiple strategies, with Cognitive Reappraisal being the suitable one. By correctly choosing it, the child understands that these feelings are valid and natural, as they arose from desire and a negative comparison. At this point, the level introduces the emotion joy, framed by the mother's intervention, to reinforce the idea that the most important thing is the happiness of both, encouraging the child to share his brother's joy.

Figure 6.14: Mini-game '*Puzzle das Emoções*' to recognize the emotion of jealousy

The mini-game '*Caixa da Alegria*' (Figure 6.15) arises after the emotional conflict and encourages the child to focus on positive and happy elements. In this game, several emojis with happy and sad expressions fall from the top of the screen, prompting the child to move a box sideways

to catch only the happy faces. The goal is to fill the box with happiness, thus promoting a playful association between identifying facial expressions and valuing positive emotions.



(a) Catching a positive emoji

(b) Catching a negative emoji

Figure 6.15: Mini-game '*Caixa dos Sorrisos*'

The level ends with the transformation of a negative emotional reaction into a gesture of understanding and emotional connection, nurturing empathy with others.

6.2.4 Level 4: O Grande Teste

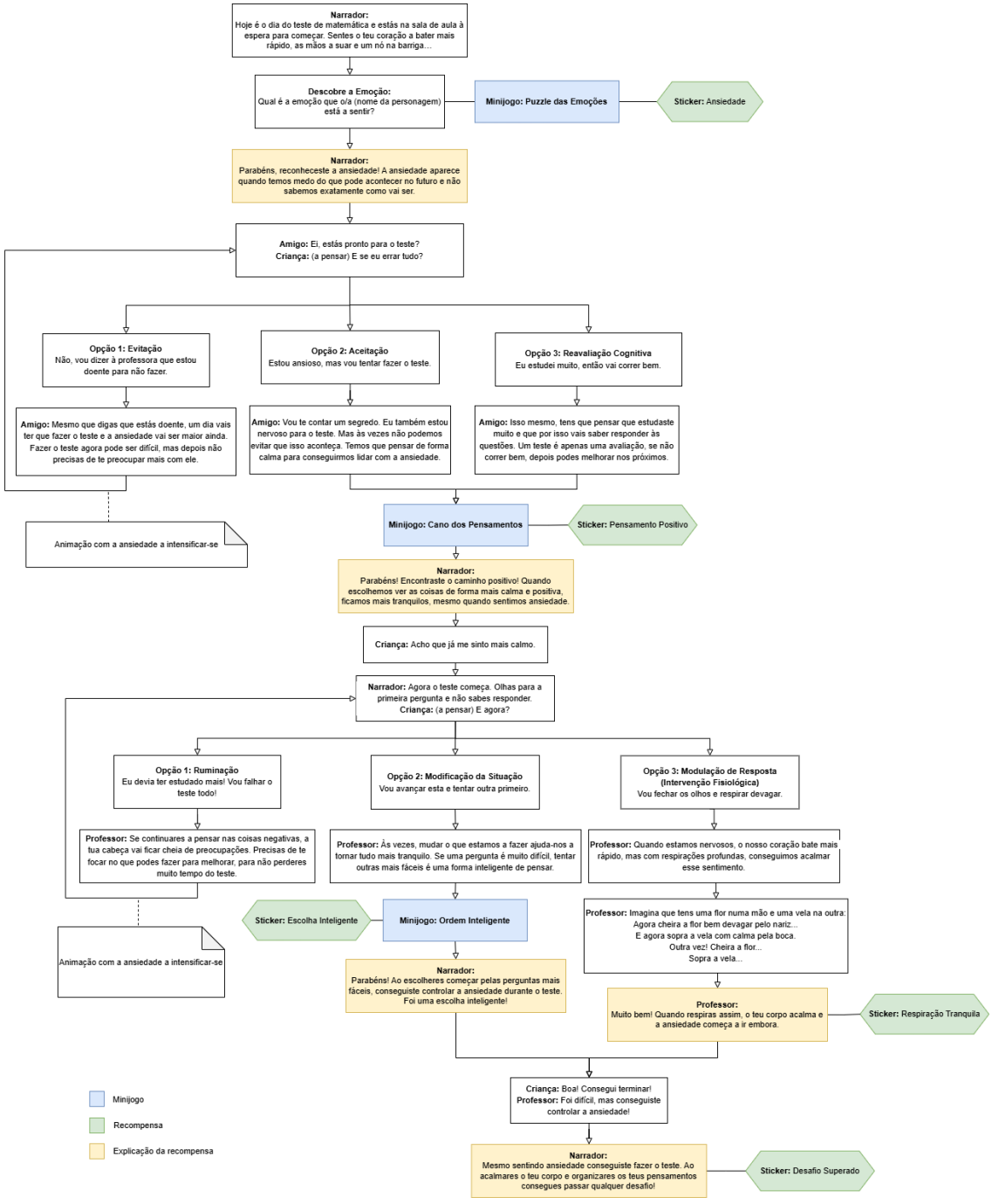


Figure 6.16: Game flow chart - Level 4

On the fourth level, '*O Grande Teste*' (Figure 6.16), the emotion depicted is anxiety and requires the application of ER strategies on two occasions during the narrative. For the following levels, the storyline transitions from at-home scenarios to school settings, introducing new contexts. This story unfolds in the classroom, where the character is preparing to take a math test. In this initial moment, a colleague approaches the child to talk before the test starts, but the child is already

showing signs of anxiety, through visual cues such as a red pulsing heart and beads of sweat dropping from his head (Figure 6.17).

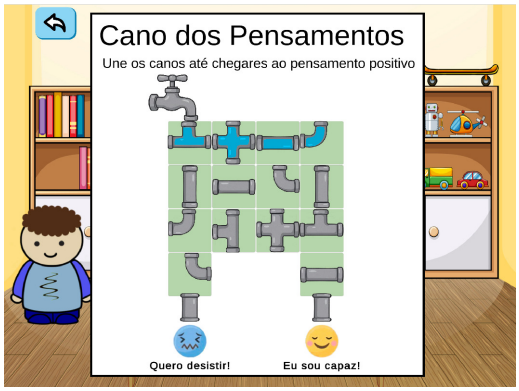
(a) Story contextualization (b) Friend's dialogue line

Figure 6.17: Level 4 storyline

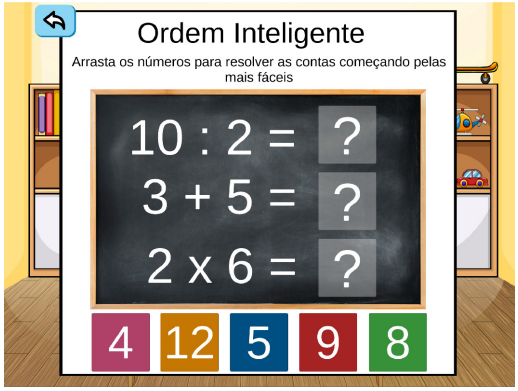
After recognizing the emotion (Figure 6.18), the first moment of emotional management follows, where the child chooses between three strategies: avoidance, acceptance, and cognitive reappraisal.

Figure 6.18: Mini-game '*Puzzle das Emoções*' to recognize the emotion of anxiety

The last two are adaptive strategies for this situation and lead to the mini-game '*Cano dos Pensamentos'* (Figure 6.19a), which is a visual metaphor for the organization of thoughts during anxiety moments. The child observes a set of disorganized water pipes and must click on each pipe to turn it clockwise, establishing a continuous flow from the source pipe to the final one with the positive thought. The positive pipe is depicted through an emoji with a calm expression, with the following message below: "*I can do it!*". Whereas the negative pipe is illustrated through an emoji with a stressed expression and the following message: "*I want to give up*". Additionally, the water, represented by a slight blue tone, only flows when there is a connection between pipes. The game is designed so that there is always a possible path to the positive thought, but never to the negative one, to facilitate the child's success and reinforce the focus on adaptive ER.



(a) Mini-game '*Cano dos Pensamentos*'



(b) Mini-game '*Ordem Inteligente*'

Figure 6.19: Level 4 mini-games

Once this first emotional challenge is overcome, the character takes their seat at the desk, now facing the test sheet laid out in front of them. Additionally, the friend who was previously offering support is no longer present, and a new character, the teacher, is introduced, playing a guiding role in the next interactions. This transition marks the beginning of the test and the onset of a second peak of anxiety (Figure 6.20), triggered by the uncertainty of not knowing how to answer the first question. At this point, a new set of ER strategies is proposed for the child to choose.

By choosing the strategy corresponding to situation modification, the child accesses the mini-game '*Ordem Inteligente*' (Figure 6.19b), in which they have to answer three math questions by degree of difficulty, in the correct order of addition, multiplication, and division. The child drags the correct numbers into the answer boxes, being encouraged to start with the easiest ones. When trying to answer in a different and more difficult order, the game shows a help message, guiding the child to try a simpler question first. This mini-game was designed to promote the idea of dealing with challenges gradually and strategically to overcome highly emotionally demanding situations.

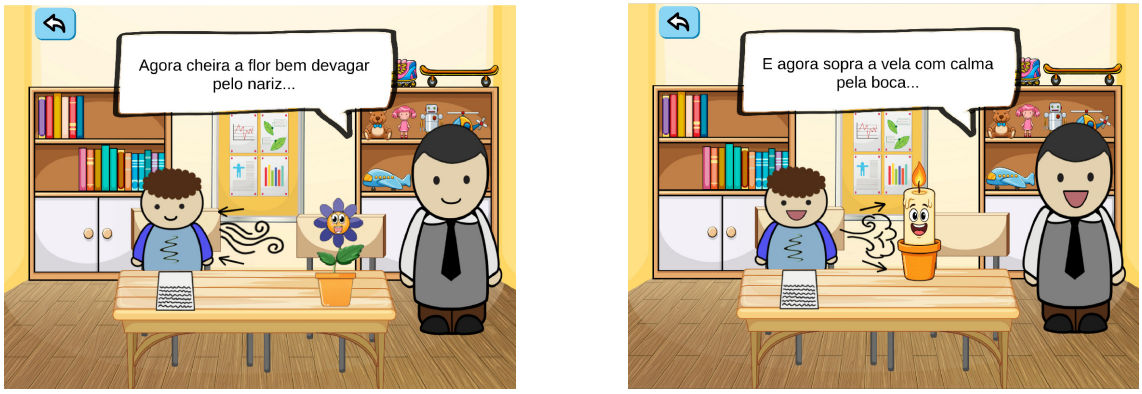
(a) Second part contextualization

(b) Teacher's dialogue line

Figure 6.20: Level 4 - Second peak of anxiety

If choosing the other positive strategy, response modulation, the child is introduced to a breathing technique called '*The Candle and the Flower*' (Figure 6.21). Although it's not a mini-game,

this interactive part has the teacher's character guiding the child through simple breathing motions, with a candle and a flower on top of the table to visually reinforce the learning process. The breathing motions are illustrated through intuitive animations with pulsing arrows indicating the flow of air: inhaling the flower's perfume and exhaling into the candle. With this technique, the game aims to promote the child's physiological self-regulation.



(a) Animation to inhale

(b) Animation to exhale

Figure 6.21: Candle and flower breathing technique

The level ends with the completion of the test, symbolizing success in managing two distinct moments of anxiety with the application of different ER strategies and reinforcing that sometimes it is necessary to take more than one step to regulate an emotion.

6.2.5 Level 5: Falar em Público

The fifth level, '*Falar em Público*' (Figure 6.22), approaches the emotions of embarrassment and joy, the latter in a final phase of the narrative. The story takes place in a classroom setting, with several students sitting at their desks and the teacher positioned on the right side of the room, asking the child to read their text aloud, causing him to feel embarrassed (Figure 6.23a). This situation is visually represented by the character holding their notebook, while blushing slightly and beads of sweat dripping from his forehead, conveying his discomfort.

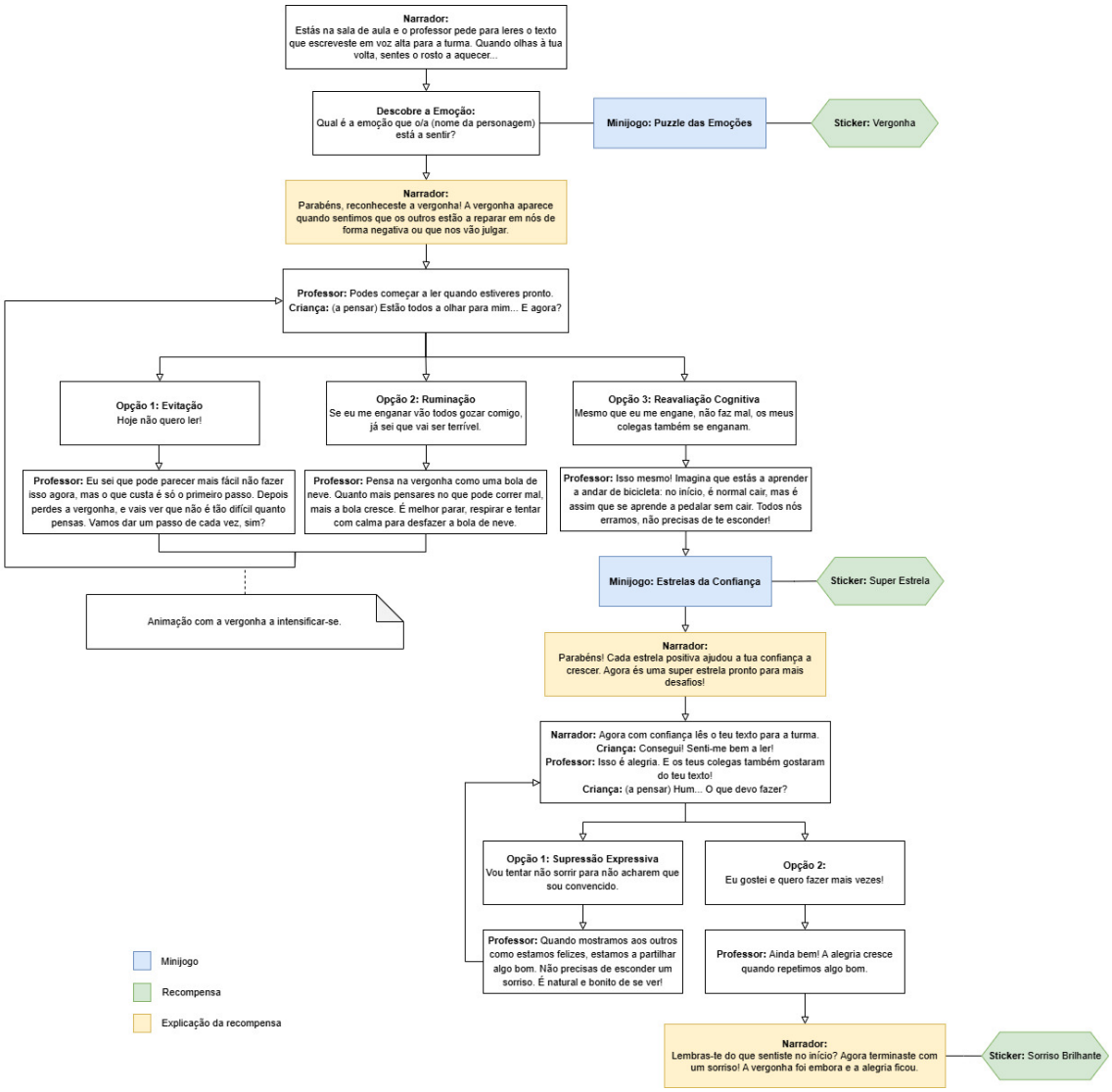


Figure 6.22: Game flow chart - Level 5

(a) First part

(b) Second part

Figure 6.23: Level 5 storyline

Upon correctly identifying the emotion (Figure 6.24), three ER strategies are presented, with cognitive reappraisal triggering the mini-game '*Estrelas da Confiança*'.

Figure 6.24: Mini-game '*Puzzle das Emoções*' to recognize the emotion of embarrassment

In this mini-game (Figure 6.25), a frog is shown with a paper bag covering its face, symbolizing its embarrassment. As a series of stars appear and disappear on the screen, each containing either positive or negative elements, the child must click only on the positive stars to boost the frog's confidence. When clicking on negative stars, the frog looses his confidence again. This boost is visually represented by a gradual transformation: firstly, the frog's face is covered by the paper bag, secondly, the frog takes off the paper bag and uses only his hands to hide, and lastly the from removes its hands and smiles confidently.

Figure 6.25: Mini-game '*Estrelas da Confiança*'

With this new encouragement, the character reads their text aloud, initiating the second part of the story (Figure 6.23b), and introducing the emotion of joy as a positive outcome of overcoming the embarrassment. At this point, the classmates' expressions change to big happy faces that show admiration, and the child must now decide how to respond to this moment of shared joy. Through the teacher's character, the game reinforces that expressing joy is healthy and important, especially when celebrating personal achievements with others.

The level concludes on a positive note that encourages emotional openness and social connections.

6.2.6 Level 6: Zanga no Recreio

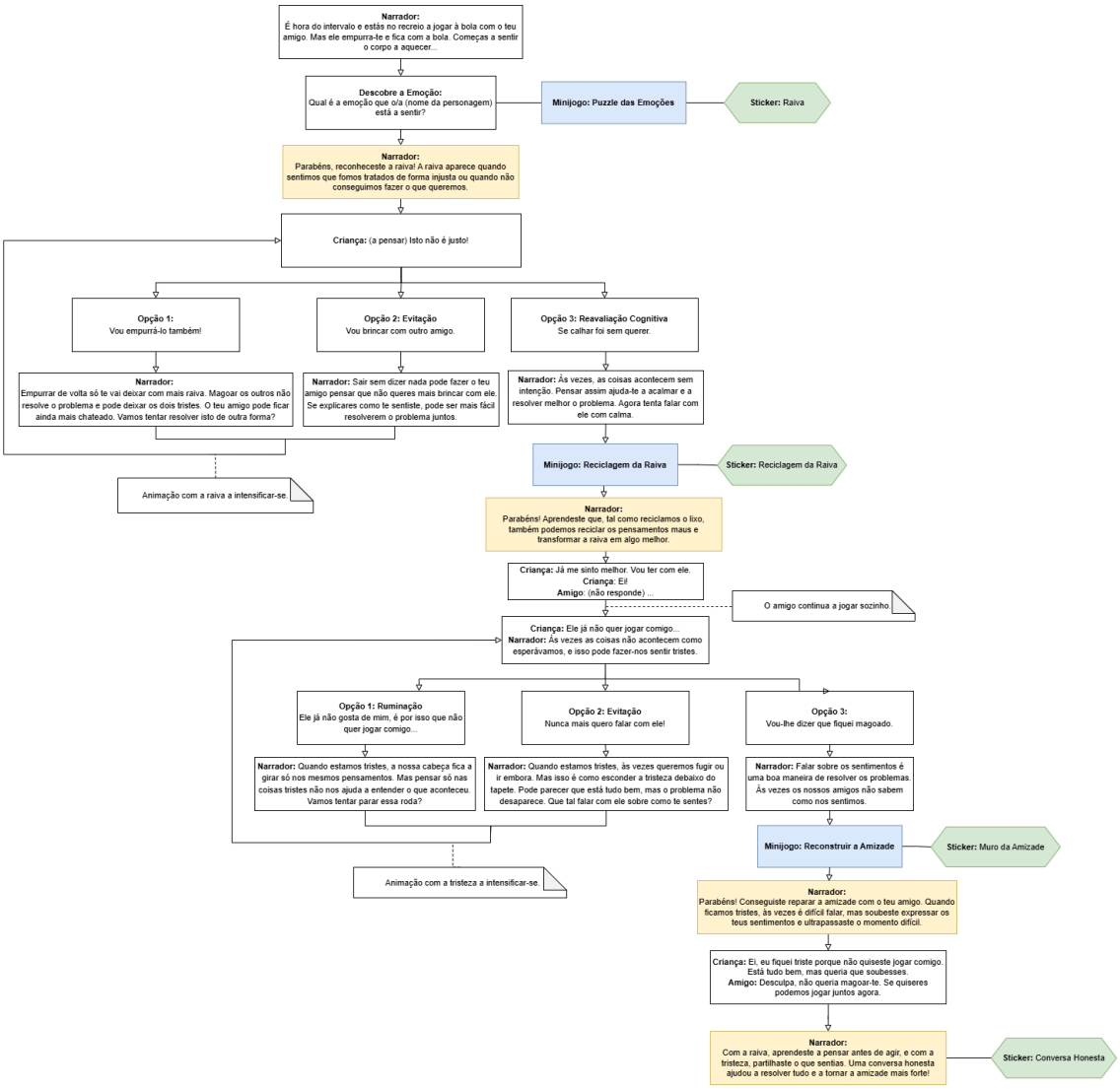


Figure 6.26: Game flow chart - Level 6

The sixth and final level, '*A Discussão no Recreio*' (Figure 6.26), is emotionally demanding and longer than previous levels, as it explores two strong emotions: anger and sadness. The narrative takes place in the school playground (Figure 6.27a), where the main character is playing with a friend, but an emotional reaction of anger arises when the friend suddenly pushes the child and takes the ball.

Upon recognizing the emotion of anger (Figure 6.28), the child is presented with different ER strategies, for which the selection of cognitive reappraisal leads to the mini-game '*Reciclagem da Raiva*', designed to help the child learn how to "throw away" harmful reactions associated with anger and focus on a calmer mindset.

(a) First part

(b) Second part

Figure 6.27: Level 6 storyline

Figure 6.28: Mini-game '*Puzzle das Emoções*' to recognize the emotion of anger

In '*Reciclagem da Raiva*' (Figure 6.29a), several thought bubbles float on screen, with some containing positive images, such as friends hugging, holding hands, or peaceful scenes, whereas others show negative reactions, like someone screaming, hitting, or expressing visible rage. The goal is for the child to drag each bubble to the correct recycling bin: a smiling bin for happy and calm thoughts, and an angry bin for violent or negative ones. This visual metaphor of sorting and letting go helps children process anger and understand that while the emotion is valid, destructive reactions are not helpful.

Once the child has cleared their mind and calmed down, the story progresses into its second part, where the character tries to talk to the friend, but is ignored, leading to an emotional peak of sadness (Figure 6.27b). To address this emotion, the child is introduced to the mini-game '*Reconstruir a Amizade*' (Figure 6.29b), in which a wall decorated with colorful and joyful stickers is now broken with missing pieces, symbolizing the friendship that has been damaged. Additionally, on the wall, underneath each missing section are the words 'smile', 'union', and 'help', representing key elements in healthy relationships. Around the wall are six pieces, with three of them matching the themes of the words, while the other three represent opposing values. To complete this mini-game, the child must drag the correct pieces to restore the wall, thereby fostering emotional

healing and repairing the friendship.

(a) Mini-game '*Reciclagem da Raiva*'

(b) Mini-game '*Reconstruir a Amizade*'

Figure 6.29: Level 6 mini-games

Once the mural is whole again, the character tries again to speak to their friend, with empathy and openness this time, resulting in their reconciliation and playing together once more.

6.3 Menus

6.3.1 Main Menu

When the player opens the game, they are presented with the main menu (Figure 6.30), where two options are available: start the game or exit. In case this is not their first time booting the game, the system will automatically load previously saved progress, including data such as the character previously chosen, levels already completed or unlocked, stickers collected, and activities previously filled in the notebook. This functionality allows children to return to the game and continue from where they left off without having to repeat any part.

Figure 6.30: Main menu

6.3.2 Level Selection Menu

After starting the game, the player is shown the level selection menu (Figure 6.31), in which they can choose which emotional challenge they want to play. The levels are divided into two big scenarios, home and school, both designed with houses in an open layout, where the interiors of each building are visible and clearly divided into rooms or areas. This chosen design for the environment ensures that children can easily understand the context of each level without opening it.

The leftmost building is the character's house, in which there are three distinct rooms: the bedroom, located on the second floor, and the living room and dining room, both located on the ground floor. The second building represents the school with two different classrooms, and a playground on the right side, featuring a slide and other typical elements found in children's play areas. At the beginning of the game, only the bedroom is unlocked and all other levels are marked with a padlock icon, stimulating a sense of progression. Additionally, the menu also includes three options below the levels' layout, to allow the return to the main menu, open the notebook, or choose a character.

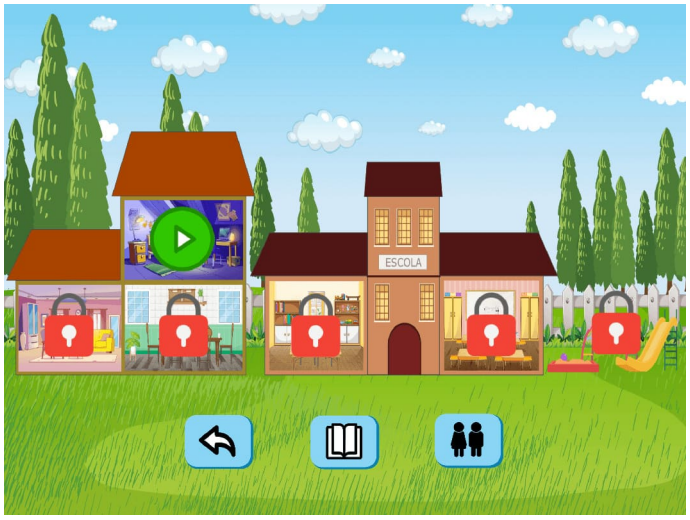


Figure 6.31: Level selection menu with only the first level unlocked

6.3.3 Character Selection Menu

In the character selection menu (Figure 6.32), the player has two character options available, a boy and a girl, both with a simple and cute visual style, to appeal to the age group of the target audience. In addition, the player can also choose a name for their character, reinforcing the sense of relatability and personalization. This choice is not final, as at any time during the game, the player can return to this menu to change both the character and its name without affecting the progress previously made, guaranteeing the experience remains adaptable to the child's preferences.

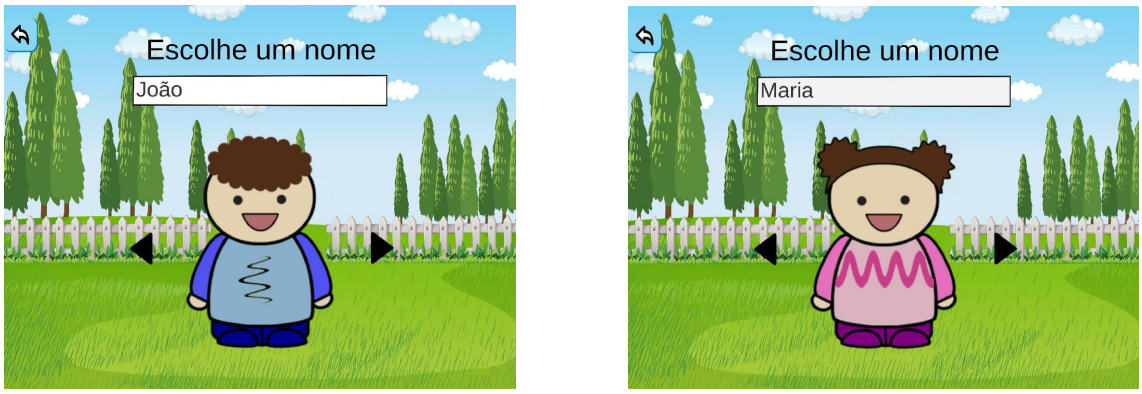


Figure 6.32: Characters available for selection

Character selection is an important feature in *EmotiToon*, given that it helps to create a more personal and immersive experience, inciting the child to feel like an active part of the presented stories.

6.3.4 Notebook Menu

One of the most important aspects of this game is the notebook titled '*O Grande Livro das Emoções*' (Figure 6.33), which consists of an interactive and personalizable book that tracks the child's emotional progress throughout the game experience. With this notebook, the child is provided with a space for reflection, learning, and individual expression that can also be shared with their parents or caregivers. Interactions with the digital book include collecting stickers and completing simple activities.

Throughout the game, the player will receive illustrative stickers (Figure 6.34) as rewards for overcoming emotional challenges. These stickers include a representative image of their purpose, an identification number, and a name. Initially, the notebook is empty, with no stickers attached or activities completed, but as the game progresses, the obtained rewards are stored in an inventory of stickers that have not yet been pasted. To place a sticker, the player has to search for the

Figure 6.33: Notebook '*O Grande Livro das Emoções*' with stickers to place

Figure 6.34: All available stickers

corresponding number in the notebook and drag it to the correct location. As soon as the sticker is placed, a short explanatory text of its meaning appears, matching the narrator's dialogue line when the reward was granted. Table 6.2 contains a description of each sticker as well as the level at which they were awarded. These descriptions will be presented in Portuguese exactly as they appear in the game.

To facilitate navigation, the notebook is organized by emotion, in the order the emotions are addressed throughout the levels. Each emotion includes one or more activities that encourage the child to think about their own emotional experiences, with questions such as "Have you ever felt [emotion]?", "What makes you feel this way?", or "What do you usually do when you feel [emotion]?". These activities range from writing exercises in which the child clicks on an area with lines and writes freely using the device's keyboard, or questions with multiple choices, where the child clicks on the squares corresponding to the options chosen. These moments of self-reflection are designed to be carried out with an adult, allowing parents, caregivers, or educators to actively participate, supporting meaningful conversations about emotions in a way that is engaging for the child.

In addition to the activities, the notebook also has an educational component presented through clear and simple explanations of each covered emotion, always including a simple definition of the emotion, and examples of common triggers. All the educational content is based on studies carried out by Ekman [53, 54] to ensure that the emotional learning conveyed by the game is scientifically grounded and pedagogically appropriate. The content present in the notebook is not only aimed at the child but is also valuable for parents and caregivers, as it can enhance adults' own understanding of emotional concepts and promote their learning alongside the child. This additional purpose aligns with insights gathered during the first phase of the co-design process, in which psychologists reinforced the importance of equipping parents with the knowledge needed

Table 6.2: Explanation of the stickers

Level	**Name**	**Unlocked by**	**Description**
Level 1	Medo	Mini-game	O medo aparece quando achamos que algo nos pode fazer mal, mesmo que não seja de verdade.
	Lanterna Mágica	Mini-game	Usaste a lanterna para iluminar as sombras e descobriste que não era um monstro.
	Medalaha da Coragem	Completing Level	Superar o medo é uma grande conquista! Agora sabes que, com coragem, podes enfrentar qualquer desafio que aparecer no teu caminho.
Level 2	Nojo	Mini-game	O nojo aparece quando algo parece estranho ou nos faz sentir desconfortáveis, como um cheiro mau.
	Chef de Cozinha	Mini-game	Aprendeste a reconhecer os ingredientes no teu prato e a experimentar novos sabores. Estás no caminho certo para ser um verdadeiro chef!
	Explorador de Sabores	Completing Level	Explorar novos sabores é uma aventura! Mesmo que ainda não adores, sabes que esses alimentos fazem bem à tua saúde e vão ajudar-te a ser ainda mais forte e saudável.
Level 3	Ciúme	Mini-game	O ciúme aparece quando sentimos que alguém tem algo que nós também queríamos, como um presente, atenção ou carinho.
	Caixa da Alegria	Mini-game	Conseguiste encontrar muitos sorrisos ao teu redor! Agora a tua caixa está cheia de alegria para partilhares com quem mais gostas.
	Coração Grande	Completing Level	O teu coração ficou apertado com ciúmes, mas conseguiste abri-lo para entender os sentimentos dos outros. De cada vez que fazes isso, o teu coração cresce!
Level 4	Ansiedade	Mini-game	A ansiedade aparece quando temos medo do que pode acontecer no futuro e não sabemos exatamente como vai ser.
	Pensamento Positivo	Mini-game	Encontraste o caminho positivo! Quando escolhemos ver as coisas de forma mais calma e positiva, ficamos mais tranquilos, mesmo quando sentimos ansiedade.
	Escolha Inteligente	Mini-game	Ao escolheres começar pelas perguntas mais fáceis, conseguiste controlar a ansiedade durante o teste. Foi uma escolha inteligente!
	Respiração Tranquila	Choice Made	Muito bem! Quando respiras assim, o teu corpo acalma e a ansiedade começa a ir embora.
	Desafio Superado	Completing Level	Mesmo sentindo ansiedade conseguiste fazer o teste. Ao acalmares o teu corpo e organizares os teus pensamentos consegues superar qualquer desafio!
Level 5	Vergonha	Mini-game	A vergonha aparece quando sentimos que os outros estão a reparar em nós de forma negativa ou que nos vão julgar.
	Super Estrela	Mini-game	Cada estrela positiva ajudou a tua confiança a crescer. Agora és uma super estrela pronta para mais desafios!
	Sorriso Brilhante	Completing Level	Lembras-te do que sentiste no início? Agora terminaste com um sorriso! A vergonha foi embora e a alegria ficou.
Level 6	Raiva	Mini-game	A raiva aparece quando sentimos que fomos tratados de forma injusta ou quando não conseguimos fazer o que queremos.
	Reciclagem da Raiva	Mini-game	Aprendeste que, tal como reciclamos o lixo, também podemos reciclar os pensamentos maus e transformar a raiva em algo melhor.
	Muro da Amizade	Mini-game	Conseguiste reparar a amizade com o teu amigo. Quando ficamos tristes, às vezes é difícil falar, mas soubeste expressar os teus sentimentos e ultrapassaste o momento difícil.
	Conversa Honesta	Completing Level	Com a raiva, aprendeste a pensar antes de agir, e com a tristeza, partilhaste o que sentias. Uma conversa honesta ajudou a resolver tudo e a tornar a amizade mais forte!

to support and strengthen emotional education in everyday life.

When designing this feature, there were careful considerations regarding its visuals to keep it appealing and familiar to children. Given the impact of the movie *Inside Out* with its young audience, the game follows its color scheme for each emotion to avoid conflicts in emotional association and perception. Figures 6.35 and 6.36 illustrates all pages of the notebook already filled with all the stickers. Furthermore, taking inspiration from the idea of having characters associated with emotions depicted in the movie, the notebook also includes an expressive monkey, assuming the facial expressions of each emotion. The monkey also changes color according to the highlighted emotion, helping to visually reinforce the emotional information.

Figure 6.35: Notebook pages (1–6) with stickers placed

Figure 6.36: Notebook pages (7–10) with stickers placed

6.4 Game Engine and Tools

6.4.1 Unity

Game engines are software frameworks very important in the development of video games, due to their incredible power in helping game developers create and manage components such as graphics, movement, sound, physics, and controls [58]. Instead of programming everything from the beginning, developers use these frameworks to save time and work efficiently.

Some of the most well-known game engines include Unity, Unreal Engine, and Godot. Although the systematic review did not provide much information about the game engines used, Unity was mentioned in some of the studies as the framework chosen for the development of SGs. One of its key advantages is being easy to use, with a simple and intuitive interface and clear documentation, active forums, and tutorials, making it suitable for both beginners and professionals. Additionally, it has cross-platform support, allowing to write the game code once and publish it on various platforms, including PC, mobile, consoles, or web.

Considering these strong reasons and previous experience with the framework, Unity was ultimately chosen as the game engine for *EmotiToon*.

6.4.2 Audacity

Given that the target audience ages vary between 6 and 9 years old, reflecting children attending elementary school, it is important to take into account the possibility that some don't yet know how to read. Therefore, to accommodate all developmental phases, the game heavily relies on audio for the dialogues between characters, allowing children to listen to the characters' voices while reading the text parts, if possible.

For this reason, there was a clear need for a tool to edit audio files and export them in a format supported by Unity. Audacity is a well-known free audio editing software that allows recording sounds, editing, adding effects, and exporting in various formats, such as MP3 and WAV [59]. This was a tool essential in creating the audio files for the game.

6.4.3 Inkscape

Inkscape is a free vector graphics editor that can be used to create or edit vector images such as illustrations, diagrams, line art, logos, and complex paintings [60]. It provides powerful drawing tools, supporting layers and various import and export formats. These features make Inkscape a strong choice for graphic design, web design, and digital art. During the game development, this tool was crucial in creating the game's assets, including the logo.

6.4.4 Ink

Ink is a scripting language used to write interactive stories and narrative-driven games, very simple to learn as it allows users to focus mainly on writing plain text, with code and logic inserted only where needed [61]. One of Ink's strongest features is its dedicated editor, Inky, which enables users to write and test stories directly in the editor, instantly play through the narrative, and export stories to JSON for use in game engines like Unity or directly to the web.

Ink supports branching dialogues, player choices, story variables and conditions, built-in tags for controlling behavior, and dynamic flow control including jumps, functions, and randomization, allowing for the creation of more complex stories. A key reason for choosing this tool is its great integration with Unity via a plugin, automatically recompiling Ink files as they are edited, making iteration and testing fast and efficient.

During the development of the game, there was a need to have a central tool responsible for controlling each level's narrative and gameplay flow, in order to make the game modular and scalable. Therefore, Ink was employed to achieve a clean separation between narrative and code, making it easier to manage complex dialogue systems while maintaining code readability. Consequently, each level of the game had its own Ink file, comprising its entire flow, including dialogue, choices, and progression. With this approach, adding new levels became a simple task by simply creating new Ink files without needing to modify the core game code. Additionally, the tags' built-in feature played a crucial role in connecting the narrative with gameplay and visuals, as it allows the attachment of extra information to specific parts of the story. These tags are written using the

'#' symbol and can appear on the same line as dialogue to trigger certain actions. The tags used in the game are presented in Table 6.3.

Table 6.3: Tags used in the Ink files

Tag	**Description**
#portrait:[object]	Changes the dialogue's box to one of the following: narrator, thought, left speech, or right speech.
#speaker:[object]	Identifies the character currently speaking, making them visible if previously inactive.
#show:[object]	Makes a specific element in the level visible.
#hide:[object]	Makes a specific element in the level invisible.
#animation:[name]	Triggers an animation on a character or object in the level. The identifier must follow the pattern 'id1_id2', in which id1 is the character or object's name and id2 is the animation's name.
#audio:[name]	Plays an audio clip.
#minigame:[name]	Starts a mini-game.
#sticker:[name]	Awards a sticker to the player.

6.5 Resources

6.5.1 Characters and Animations

Finding characters matching the desired game style proved to be a rather complicated task that involved extensive searching on various free asset websites, such as the Unity Asset Store and itch.io. The goal was to find 2D characters with a cartoon-like style, visually appealing and expressive enough to represent a variety of emotions throughout the narrative. Additionally, it was essential to guarantee a base set of main characters with coherent styles: a girl and a boy representing the child, the mother for the home scenes, and the teacher for the school scenes. After a long search, an SVG file originally created by anarres and later reorganized by melaniko was found on the opengameart.org website, containing a variety of "mix and match" child models that allowed for the customization of hair, clothes, facial expressions, and body postures (Figure 6.37). This template file only included models for the boy and girl characters, but showed great potential for the possibility of also creating the mother and teacher characters from it.

The Inkscape tool, recommended by the author of the models, allowed for editing the SVG file and developing the necessary characters for the game. First, the girl and boy characters (Figure 6.38) were developed with clothes and hair that were characteristic of children, making it easier for players to identify and relate to the protagonists. For each gender, multiple sprites were created with various facial expressions, distinct enough to convey the emotions clearly. Over the course

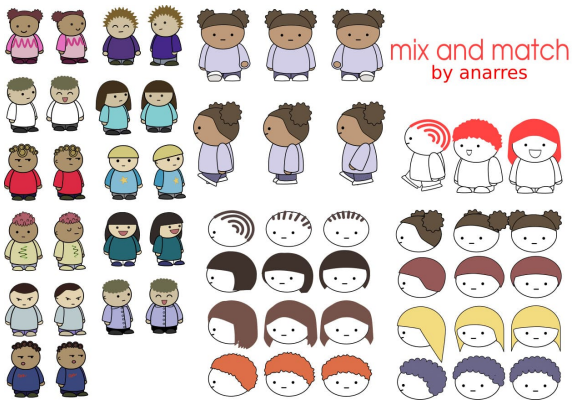


Figure 6.37: Template image for all characters in the game

of the game's development and as new levels and emotional situations were added, these sprites underwent several changes to expand the range of facial expressions, many of which were not initially represented in the template, requiring their design from scratch.

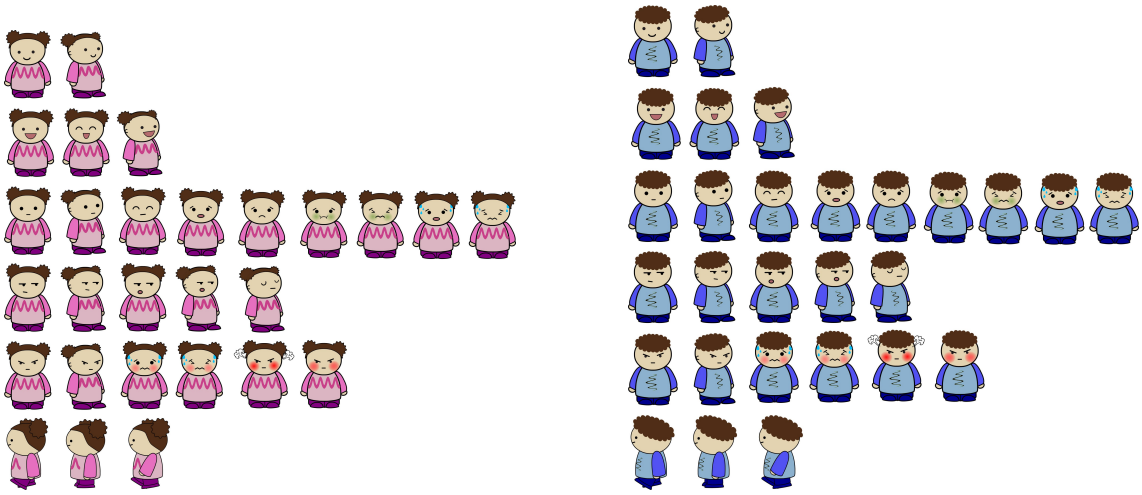
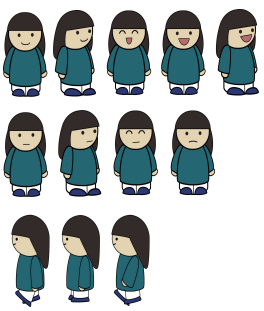


Figure 6.38: Sprite sheets for the girl and boy characters

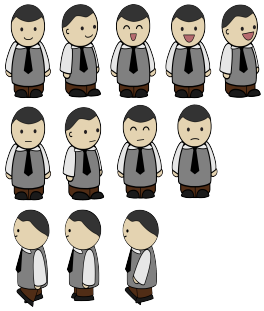
Afterwards, the mother and the teacher characters were developed, as illustrated in Figures 6.39a, 6.39b. The mother was created from one of the child models, adapting the height and width so that she resembled an adult figure. This character was designed to be dressed simply, in two colors and without patterns on the shirt, to reinforce her role as a caregiver. On the other hand, the teacher required more work, as there was no good enough model to serve as a basis. A typical teacher's outfit was then designed, with a white shirt, gray sweater, and black tie, also adjusting the height of his model to appear an adult. For these two characters, not as many facial expressions were created, since emotions such as anger, disgust, or jealousy would not be part of their narrative.

Although initially unplanned, two new characters (Figures 6.39c, 6.39d) were also created as they were necessary for some of the levels: the brother and the friend. Whilst sharing the same

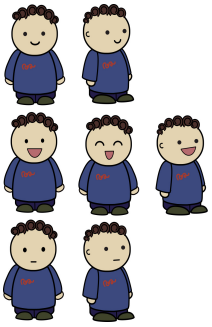
hair type, they differ in skin tone, hair color, and clothing. Additionally, for level 5, it was also fundamental to design more child models to take on the role of classmates during the lesson. To minimize the time spent on this task, only sprites of the characters seated were drawn (Figure 6.40), with just the necessary expressions for before and after the child read the text. As required by the narrative, this included neutral or serious expressions at the beginning of the story and joyful ones at the end.



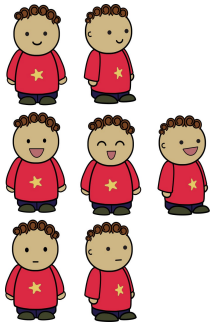
(a) Mother character



(b) Teacher character



(c) Brother character



(d) Friend character

Figure 6.39: Sprite sheets for the secondary characters

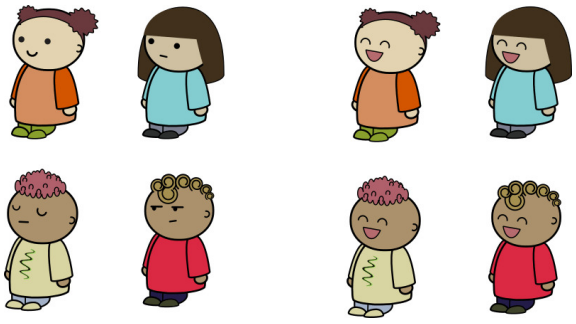


Figure 6.40: Sprite sheet for the colleagues' characters

Table 6.4 shows all the implemented animations, derived from the facial expressions created. It is important to note that most of the emotions include variations, such as happy and very happy or angry and very angry, which enrich the characters' emotional performance and make it possible to represent the emotions' intensification.

Table 6.4: Available animations for each character

Animations	**Child**	**Mother**	**Teacher**	**Brother**	**Friend**
Happy	X	X	X	X	X
Disgusted	X				
Angry	X				
Jealous	X				
Serious	X	X	X	X	X
Anxious	X				
Embarrassed	X				
Afraid	X				
Sad	X	X	X		

6.5.2 Graphic Assets

Given that the characters were the first assets to be chosen for the game, all other elements had to be carefully chosen or developed to maintain a coherent visual identity that appealed to the target audience. This meant that a cartoony and colorful style should always be adopted, marking a strategic decision to capture and keep children's attention throughout the game experience. With that in mind, this visual consistency was applied to all areas of the game, from the start menu, through each level and its mini-games, to the interface elements.

The selection process went through an intense search phase, since it wasn't always easy to find free materials that followed the exact desired aesthetics. Whenever that wasn't possible, the assets were designed from scratch using Inkscape and Canva [62] tools, depending on the nature of the graphic element.

The game's logo (Figure 6.41) is one of such example of original creation, being designed using Inkscape tools, and combining just a speech bubble and the game's title in an animated font. The goal with this simple design is to immediately convey, through its visuals, the idea of a narrative and cartoony game centered on emotions.

Figure 6.41: Logo of *EmotiToon*

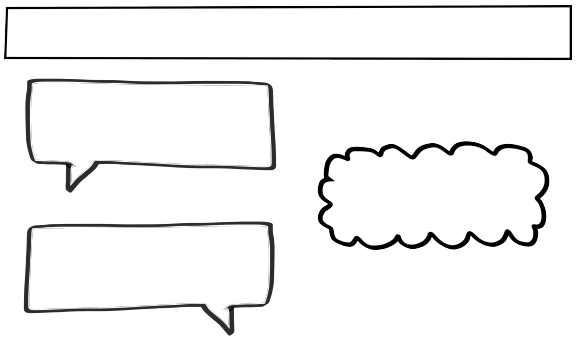


Figure 6.42: Text boxes for speech, thoughts, and narrator's lines

Furthermore, the level selection menu (Figure 6.31) was also designed in Inkscape. It is composed of a background image with a lawn, a tree line, and a blue sky, creating a peaceful environment for the game. Two buildings were added, designed from scratch to represent the character's house and school, which are the central environments of the game. To represent the rooms in each building, the background images of the levels were used, which were collected from free-licensed websites and deliberately chosen to ensure the context of each scene is immediately clear to the child.

During the dialogues within the levels, specific text boxes (Figure 6.42) have been used to indicate who is speaking, reinforcing the clarity of the communications. There are four distinct types of text boxes: the left speech bubble, used by the child's character; the right speech bubble, used by secondary characters, such as the mother, teacher and friend; the thought bubble, always used to represent the child's character thoughts; and a rectangle at the top of the screen, reserved for the narrator to introduce, contextualize or give feedback during the narrative.

The mini-games integrated into each level were designed with an intentionally minimalist approach, aiming to avoid overcomplicating these challenges and excessive visual stimuli that could confuse children. Several of the assets used in these mini-games were collected from free-licensed websites and then edited in Inkscape or Canva to match the overall style of the game. In some instances, the graphic elements were directly found in Canva. Figure 6.43 illustrates the main assets used for this feature.

As it was previously mentioned, the sticker notebook is one of the central elements of the experience, therefore requiring special attention during its design. The entire design was developed from scratch in Canva, incorporating great care and detail. Firstly, the cover (Figure 6.30) displays the game's title in large, animated letters, accompanied by images of some of the emotions portrayed in the levels. Secondly, each sticker (Figure 6.34) was thought to have a consistent design, varying only in identification number, illustrative image, and name, avoiding sudden style changes that could cause misunderstandings. In addition, an original mascot, a monkey, was created for the notebook with various colors and emotional expressions, designed with the support of ChatGPT's free capabilities. This mascot appears throughout the notebook pages to reinforce children's involvement and interest in the reward system. All the other elements used in this feature were available on Canva as free-to-use resources.

Figure 6.43: Assets used in the mini-games

Finally, other elements present in the game's interface, such as navigation icons and buttons, were obtained from the SVGRepo website.

6.5.3 Audio Assets

The audio in the game is exclusively present in the characters' voices, a deliberate choice to keep the focus on the emotions and the narrative, without resorting to background music or additional sound effects that could distract children.

To generate these voices, the Narakeet website was used, which is an online text-to-speech tool that allows the creation of voice files based on plain text. This process required the selection of one of the many voices available, typing the desired text, and the platform automatically creates an audio file with the corresponding voice-over. This tool proved to be very useful for easily generating the voices for the narrator, mother, and teacher. However, one of the main challenges came in creating the child's voice, since none of the ones available on Narakeet convincingly simulated a child's voice. This limitation was overcome by adopting a two-step solution: first, the child's dialogues were converted into audio using the same voice as the mother on Narakeet, and these files were then submitted to the Weights platform to alter the original voice, adjusting its tone and apparent age. Weights is a free AI-powered platform that helps users generate and share AI voice covers from song lyrics or text-to-speech, produce AI images, and chat with AI characters. With this platform, it was possible to create two distinct children's voices, one to represent the child's character and another for the friend's character. It should be noted that although the game allows for a choice between a boy and a girl as the main character, no different voices were generated for each gender, as the created voice worked in a sufficiently neutral way to represent both cases, avoiding unnecessary duplication. Despite requiring several iterations and tests with different voices and platforms, this solution achieved good results, as the quality obtained was sufficiently natural and expressive, allowing the representation of emotions and intonations.

6.6 Implementation Details

6.6.1 Audio

The simplest solution found to correctly implement the audio in the game was through direct linking with the interactive narrative. Each level scene contains a specific script called AudioManager, responsible for managing the playback of all audio files associated with the characters' lines for that level. This audio system is then connected with the Ink file, which contains the level's narrative script. In this file, each line of dialogue has a specific tag that indicates the corresponding audio file. During execution in Unity, these tags are read and interpreted automatically, and the name of the audio file is extracted and sent to the AudioManager to be played.

Whenever the player progresses in the dialogue, the AudioManager instantly plays the audio file associated with the new speech. If the player advances to the next dialogue line before the previous audio finishes, the system stops the previous playback in progress to avoid overlapping sounds, ensuring that only one speech is heard at a time.

The only exception to this automatic playback occurs when multiple choices are presented for the child to choose an ER strategy. In these cases, instead of immediately playing the audio of all the options, only the child's thought text is played automatically. Each option contains a playback icon in the top right-hand corner, allowing the child to listen to the different options whenever they want by just clicking on the button, avoiding confusion giving more control over the experience.

With this system, the audio correctly accompanies the narrative, respecting the player's rhythm and adapting to their interactions.

6.6.2 Game Introduction

When the player opens the game for the first time, they are presented with an introduction (Figure 6.44) specifically designed to guide their first steps in the game, explaining clearly what can be done in the level selection menu. The narrator performs the introduction, while the menu's main features are shown, and is as follows:

"*Olá! Bem vindo ao EmotiToon. Aqui vais viver várias histórias e ajudar uma criança como tu a aprender e lidar com diferentes emoções. Vais poder escolher o teu personagem e dar-lhe um nome. Em cada nível, vais ganhar vários autocolantes que podes colar no teu grande livro das emoções! Estás pronto para começar esta aventura? Começa por escolher um personagem.*"

During this narration, the audio is synchronized with the visual presentation of the game elements, such as the character selection menu and the notebook, allowing the child to immediately understand the game's basic functionalities. Furthermore, this introduction is played only on the first time initiating the game.

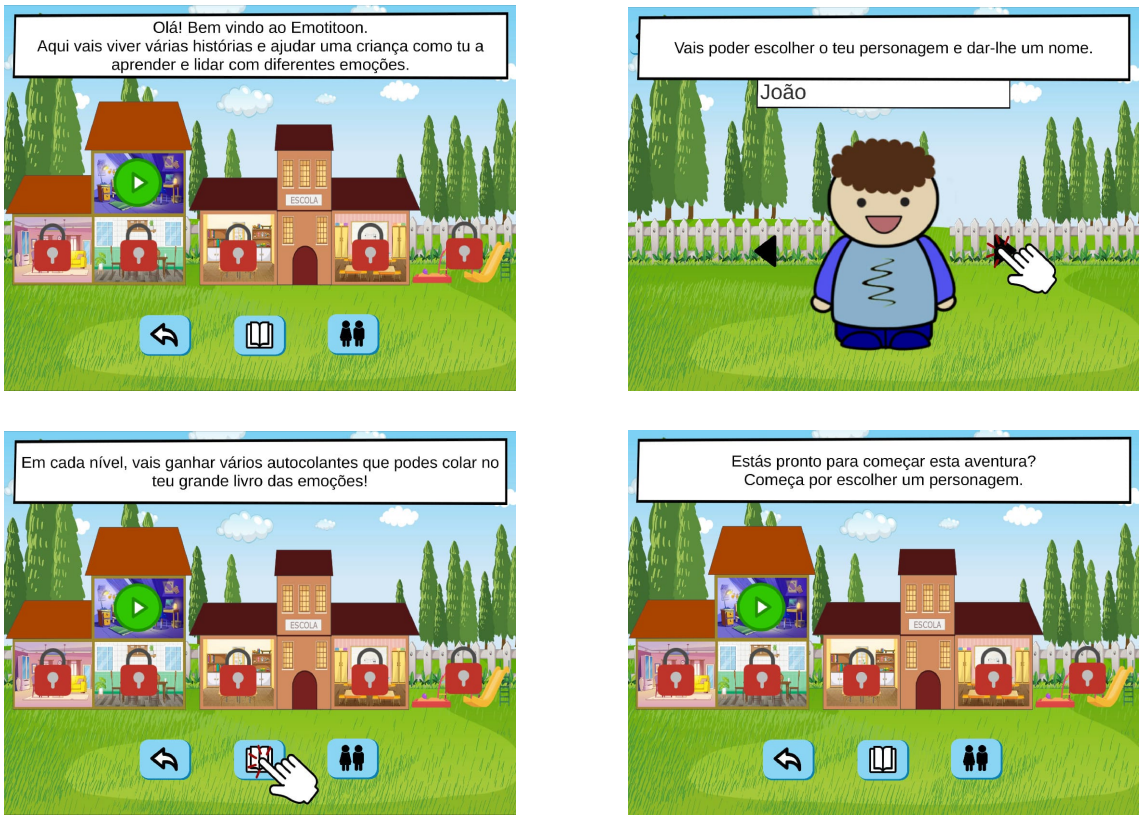


Figure 6.44: Introduction when opening the game for the first time

6.6.3 Tutorials

To ensure children easily understand the game mechanics, several tutorials are present throughout the levels, acting as a visual support whenever a new interaction is introduced. All the tutorials are shown through simple animations that only have a few seconds, with a hand moving across the screen to demonstrate the action to be performed. This approach was chosen given that it is highly intuitive and ideal for school-aged children.

Starting with the first level, an introductory animation is shown which teaches the player how to progress through the dialog by simply clicking anywhere on the screen, and how to interact with the choice moments by clicking on one of the three options that appear below the thought bubble.

In addition, each mini-game contains its own tutorial animation, which appears at the start of the challenge and demonstrates the specific mechanics to be used, whether clicking on an object or dragging it to the right place. These tutorials are always adapted to the action required in that context, promoting a greater understanding.

A particular case in point is the puzzle mini-game, which goes a step further by also including a help button that, when clicked, shows an image of the completed puzzle, acting as a constant reference. The child can keep this help visible while piecing the puzzle together to reduce frustration in more challenging situations.

These tutorials were implemented to make the game as accessible and inclusive as possible, while promoting the child's autonomy, regardless of their level of experience with video games. Figure 6.45 illustrates how the tutorials were implemented in the first level, serving as an example of how it is also present on the other levels.

Figure 6.45: Examples of animation tutorials present on the first level

6.6.4 Ending Message

Figure 6.46: Ending message for completing the game

When the player has completed all the available levels, the game displays a final celebration message, accompanied by an animation of colored confetti, to reinforce the feeling of achievement (Figure 6.46). At this point, the following message appears on the screen to highlight the player's progress and encourage them to keep exploring the game, even after completing the main levels:

"*Parabéns, terminaste o jogo! Agora podes continuar a completar a tua caderneta.*"

It is important to note that finishing the game does not prevent the player from continuing to play, as all the levels remain accessible, allowing the child to replay any of the stories whenever they want to revise a particular emotion or simply relive a favorite episode.

Chapter 7

Second Phase of Co-Design

Similarly to the first phase, the second phase of the co-design process also required reformulating the plan initially outlined, due to the previously mentioned restrictions. The original plan included validating and testing a working prototype of the game with children, parents, teachers, and psychologists to guarantee insights from the target audience and experts. As the central aim of this phase remained the same, the only significant change was to rethink the defined group of stakeholders to accommodate these limitations.

The following sections provide a detailed explanation of this procedure and the results obtained.

7.1 Procedure

The second phase of the co-design process took place when the game was at a more advanced stage of development, allowing for the full exploration of its functionalities. At that point, the prototype had all the outlined levels implemented, as well as the sticker notebook. The main objective for this phase was to identify any critical points or areas with potential for improvement, in order to make the necessary adjustments before the usability assessment. In particular, the focus of this feedback would be on the general functioning of the game, the clarity of its mechanics and interactions, and new functionalities that could still be worth integrating.

The tests were conducted in an informal way, without structured questionnaires, where each participant was invited to freely explore the game and openly share their impressions. No socio-demographic data was collected from the participants, nor were any interactions recorded, always respecting the privacy of those involved. No personal information was requested or stored, and the whole process was carried out to guarantee anonymity, respect, and voluntariness.

7.2 Participants

In the second phase of the co-design process, only children took part in the testing of the prototype, which allowed for getting perspectives from the target audience on the design and gameplay.

The sample was composed of 5 children, with an average age of 8 years old. Their involvement was possible because of the collaboration of a LIACC researcher who also works as a primary school teacher. This researcher introduced the game to the children in a school setting, ensuring that all ethical standards were respected, with no personal data collected and all interactions supervised at all times. Only one level of the game was played by children, with the support of the teacher, to ensure that the activity was seen as fun and without pressure. During this process, the teacher held a relaxed and natural conversation with the students to informally gather their perceptions and opinions, using questions such as "Can you understand what you're supposed to do here?", "What do you think of the level?", or "What would you change about the game?".

7.3 Data Analysis

Data analysis focused exclusively on children's opinions obtained during the test moments and formally written by the teacher. A qualitative analysis was performed on this feedback to identify the game's strengths and important areas for improvement.

7.4 Results

During the testing of the game's first level, several aspects were found to need improvement, while others were already found very enjoyable.

When children opened the level for the first time, they didn't immediately realize that they had to click on the screen to advance in the dialogue, which caused some confusion about how to interact with the game. After a simple explanation from the teacher, this mechanic was understood, and the children were able to proceed independently.

The first challenge of the level, corresponding to the puzzle to identify the depicted emotion, was considered slightly difficult to complete. Although children quickly realized the drag-and-drop mechanic to move the pieces, some students needed support to complete the image.

Another moment that caused some confusion was when it was required to choose an option from the multiple options given to deal with an emotional situation. Children didn't immediately understand they had to select an option, nor was there a correct option, mainly due to a lack of visual explanations.

Despite these initial difficulties, the reactions were very positive, with children showing great enthusiasm about the characters and the general concept of the game. Some suggestions came up during the conversation, specifically the inclusion of audio in the dialogue lines, since, as they were still developing reading skills, it took them some time to read each line. Additionally, children also showed interest in the possibility of choosing their own character, although they expressed their appreciation for the main character already in the prototype. When asked about the need to go back in the narrative to revise the dialogue or actions, students indicated that they didn't miss this option, mentioning that the game was already good as it was.

Overall, the teacher highlighted the great interest children had while playing the game, enjoying particularly its visual design.

7.5 Conclusions

During the second phase of the co-design process, the goal was to test a playable prototype with the target audience to obtain realistic and practical opinions about the game that would help understand what in the game was well received, what needed to be improved, and what still needed to be implemented.

This brief contact was sufficient to reveal that children's needs often only become clear by observing their behavior in a real context of use, thus being essential for detecting unexpected difficulties in usability and opportunities for improvement.

The obtained feedback reinforced the importance of an appealing visual design and animated characters, where both proved crucial in maintaining children's interest and enthusiasm. Furthermore, the testing also allowed for identifying the necessity of visual and audio guides throughout the level, especially during the mini-games, which consequently led to the addition of various tutorials whenever new mechanics were introduced, as well as the integration of audio in all the game's text parts, improving the immersion and accessibility of the gameplay. Another important suggestion consisted of the possibility to choose the playable character, making it easier for children to relate to the gaming experience.

The following table 7.1 summarizes the areas needing improvement based on the children's feedback, detailing how that particular area was before and the changes made afterwards. Through this co-design phase, a conscious effort was taken to adapt the already existent game's design to the real needs and preferences of the target audience.

Table 7.1: Improvements and changes made to the identified areas based on children's feedback

Area for improvement	**Before**	**After**
Start of level	When opening the level, no explanation of the mechanics was provided, leaving the player to experiment and discover on their own.	When opening the level, a tutorial is displayed, in which a hand appears to simulate a click anywhere on the screen, encouraging the player to mimic the movement and progress through the narrative.
Puzzle mini-game	When the puzzle mini-game is activated, the complete image is shown for 2 seconds, and then the pieces are shuffled.	A help button was added that, when clicked, shows the complete puzzle image. When the mini-game is activated, a tutorial is shown in which a hand clicks on the help button and the auxiliary image appears.
Mini-games mechanics	When a mini-game was opened, only a short sentence was present explaining what should be done to complete the challenge.	A tutorial was added to the start of all mini-games, in which a hand would simulate all the required movements for that challenge. This complemented the existing written explanation by adding a visual representation.
Decision-making mechanic	At this moment, a thought appears on screen with 3 options below, for which the player has to select one.	A tutorial was added, in which a hand appears on screen roaming through the options and selecting one.
Reading the dialogue lines	Initially, players had to read each dialogue line, although small.	Voices were added for each character, allowing audio to be played for all text parts.
Choose a character	Initially, only a boy character was available to be the player's character.	A menu was added in which the player can choose their own character and give it a name.

Chapter 8

Usability Assessment

The present chapter describes in detail the assessment performed to evaluate the game's usability and user satisfaction, as well as to identify areas for improvement to be integrated into future iterations. Furthermore, the chapter concludes with a presentation and discussion of the obtained results, asserting the game's capabilities in achieving the expected outcomes.

8.1 Procedure

The usability assessment represents a critical step in validating any interactive solution, as it provides an opportunity to gauge the system's suitability for the needs and characteristics of end users. In the particular case of this project, the assessment took place during the third co-design phase to test the final version of the game. Initially, *EmotiToon* was planned to be tested with all groups that might have an interest in using the game, particularly children, their parents, teachers, and healthcare professionals. However, due to the absence of ethical approval and the restrictions associated with it, the original plan became unfeasible, necessitating a reformulation of the process. The strategy originally outlined for the third phase included carrying out direct tests with all stakeholders, with special emphasis on children, to collect realistic and comprehensive data on the game's impact as a tool to support the development of ER skills.

Faced with the impossibility of executing such sessions, the validation strategy was reformulated to include a group of participants closest to the target audience and who were also interested in using the game. Mental health professionals have vast experience working with children and knowledge in the area of ER, allowing for informed perspectives on the potential interest children have in the game and its applicability for all contexts. Additionally, by including game designers in the assessment, it is possible to obtain critical and technical validations of the interface, game mechanics, and usability.

For the assessment, all participants were contacted by email, where the objectives of the study were clearly explained, as well as what would be expected of their participation. The same email also included a direct link to the game, accessible and to be played via browser on any platform

and without the need for installation, facilitating the whole testing process for the participants. In addition, written informed consent was also obtained from all participants.

The procedure was conducted asynchronously, respecting the time and will of each participant, allowing them to play the entire game at their own pace. After the gameplay, participants were asked to complete an open-ended questionnaire to evaluate the gaming experience and give their perceptions and suggestions. The data collection process was conducted on the platform Inquéritos U.Porto, guaranteeing anonymity and data security. The full process respected fundamental ethical principles, ensuring anonymity, security, and confidentiality of the participants' data.

8.2 Participants

For the third phase of the co-design process, a convenience sample was used, made up of two different groups: mental health professionals and a professional in the field of game design, both of whom often collaborate on LIACC studies. Mental health professionals were not necessarily the same as the participants in the first co-design phase. The game designer was contacted to obtain a more technical perspective on the game. This sample included four psychologists, one identified as male, two as female, and one who preferred not to indicate, with ages varying between 29 and 45 years (M = 36.2; SD = 5.76), and professional experience between 5 and 20 years (M = 13.0; SD = 5.43). The sociodemographic characteristics of mental health professionals are detailed in Table 8.1. The game designer is a female professional with experience in developing healthcare-related solutions.

Table 8.1: Sociodemographic data of the healthcare professionals participating in the usability assessment

Variable	***n***	***%***	***M* (range)**	***SD***
Gender				
Female	3	60%		
Male	1	20%		
Not identified	1	20%		
Nationality				
Portuguese	5	100%		
Profession				
Psychologist	5	100%		
Age			36.2 (29-45)	5.76
Years of Professional Experience			13.0 (5-20)	5.43

8.3 Measures

The original plan for the usability assessment included the usage of validated instruments widely utilized in the literature on usability testing, namely the USEQ, SUS, and ERQ questionnaires. The first two questionnaires would be completed by all participants to assess usability and satisfaction with the game, while the ERQ would only be administered to the children's parents to measure observed improvements in ER after using the game. However, given the aforementioned restrictions, it was decided not to proceed with the direct application of these instruments, and, as an alternative, an open-ended questionnaire was created, taking into account the domains present in the USEQ and SUS. Given the absence of children and their parents during testing, the ERQ domain was not relevant to include in the open-ended questionnaire, since it was not possible to assess changes in ER in children. With this approach, the procedure guarantees compliance with ethical standards while preserving the assessment objectives originally defined.

The questionnaire filled by mental health professionals was composed of open-ended questions developed specifically for this study, and organized into five sections:

- **Usability** - questions about navigation, clarity of instructions, and general opinions;
- **Satisfaction** - evaluation of interest and involvement with the game;
- **Learning and emotional development** - perception of the educational and emotional impact of the game;
- **Suggestions and improvements** - additional comments and proposed changes.

The questionnaire to be completed by the game designer focused on technical and creative aspects, including evaluation of the interface and visual design, fluidity of the game mechanics, clarity of objectives and instructions, and general user experience.

8.4 Results

Given the differences in the roles of each group of participants and the distinct questionnaires used to collect the data, the results were examined by performing two separate thematic analyses: one focused on the feedback from the game designer and the other on the responses of the mental health professionals.

This section will present the results of this analyses in two parts: 1) Technical perspectives on the game's design, and 2) Perspectives of mental health professionals on the game. Furthermore, any transcripts used in the analyses were derived from excerpts of the questionnaires, which were transcribed verbatim in an anonymized form.

8.4.1 Technical Perspectives on the Game's Design

This section presents the analysis of the feedback from the game designer whose participation was aimed at evaluating the game from a technical perspective. These results are organized into

five major themes: 1) Interface and visual clarity, 2) Instructions and tutorials, 3) Reward system and motivation, 4) Suitability for the target audience, and 5) Educational value and pedagogical design.

8.4.1.1 Theme 1: Interface and Visual Clarity

Several small modifications were recommended for improving the interface, particularly the navigation within the game, to make the overall experience more intuitive and visually clear for young players.

One of the key recommendations was the visual indication of completed levels, which would allow children to better track their progress. As the professional explained:

"*To ensure a clearer and more engaging gameplay experience, it is important for the interface to visually indicate which levels have already been completed. This gives players a sense of progress and helps them resume the game more easily. Level completion could be shown through icons, color changes, or subtle animations. This also helps avoid accidentally replaying completed levels.*"

Another suggestion was to allow players to resume the game exactly from where they previously stopped, in order to "*respect the user's rhythm and avoid unnecessary repetition*", which is especially important for maintaining motivation in children.

Regarding level introductions, the designer noted that although clicking anywhere on the screen works to move the dialogue forward, it may not be intuitive enough for children. She recommended the addition of a clearly visible button labeled 'Next' or a directional icon, such as an arrow, to provide explicit visual guidance on how to proceed, further reasoning that "*[...] children benefit from clear visual cues" and "having an obvious button for progression reduces ambiguity*".

Furthermore, the game designer also proposed the inclusion of a 'Save' button in the character selection menu, explaining that an explicit button "*ensures players understand that changes made to their character were saved successfully and eliminates uncertainty about system feedback*".

Another important aspect to take into account in the interface relates to the lack of visual contrast of the buttons in certain areas. The designer particularly mentioned the back button in the character selection and notebook menus, which appears in a shade of blue that blends with the sky background. An explanation was given as to why this is relevant:

"*An effective interface should ensure that all visual elements are easily distinguishable from one another, especially text and background, buttons and other content, and active versus inactive elements. Low visual contrast compromises readability and navigation.*"

Nonetheless, the designer praised the overall clarity and visual feedback of the interface, agreeing that the game effectively responds to player actions.

8.4.1.2 Theme 2: Instructions and Tutorials

While the game's introduction and tutorials were seen as sufficient to contextualize the experience, the game designer emphasized the importance of continuous access to instructions, especially considering the target age group. This recommendation was further substantiated by her following explanation:

"*In this age group, it is common for children not to immediately retain all presented instructions. A possible solution would be to make this information continuously accessible from the main menu, offering a more inclusive, clear, and autonomous experience. This way, the child (or an accompanying adult) can revisit these instructions whenever needed.*".

Additionally, the designer recommended the inclusion of basic instructions within specific game segments to reinforce comprehension, highlighting the need for explicit and simple guidance during key gameplay interactions, particularly for first-time users: "*To ensure an accessible and enjoyable experience for all players, the game should present clear and accessible instructions. For example, instructions like 'Drag and drop the pieces to complete the puzzle' offer a starting point and significantly reduce the learning curve.*".

8.4.1.3 Theme 3: Reward System and Motivation

The game designer expressed a positive view regarding the pacing and motivational structure of *EmotiToon*, agreeing that the rhythm of the game is suitable for maintaining children's attention and motivation throughout the experience.

A central component of this game is the sticker notebook, '*O Grande Livro das Emoções*', which was thoroughly discussed, with the designer recognizing it as an effective reward system to reinforce learning and engagement. However, there was also emphasis on the importance of ensuring that the system supports genuine emotional growth, rather than encouraging strategic or superficial behavior. Thus, the professional cautioned for the following:

"*When rewards are strongly associated with 'correct answers', it can lead to strategic response behavior, the child may choose what they consider to be the 'best answer' just to receive the reward, and this would compromise emotional authenticity, as well as detract from the objectives of the game.*"

In another statement, the designer further explained that "*if one of the aims of the game is to earn stickers to fill in the notebook, and not all the answer options allow to achieve this goal, the lack of clarity as to which option gives access to the stickers can lead to frustration [...]*".

In addition, the game designer suggested making the sticker notebook more prominent in the user experience, specifically recommending that the album be automatically displayed at the end of each level, helping to consolidate progress and reinforce the connection between completed challenges and emotional growth. The professional noted that this should be integrated naturally within the game flow so that the educational objectives remain central and engaging rather than optional or secondary.

8.4.1.4 Theme 4: Suitability for the Target Audience

According to the game designer, *EmotiToon* demonstrates a good alignment with the needs and capabilities of its intended audience, particularly with appropriate game mechanics for the age group, and intuitive interactions, allowing for smooth and natural gameplay.

The professional further praised the visual and audio style of the game, noting that it is well adapted to the preferences and comprehension levels of young children. In addition, the narrative component was considered highly suitable, with the designer agreeing that the story is not only engaging but also well integrated with the game mechanics.

8.4.1.5 Theme 5: Educational Value and Pedagogical Design

From a pedagogical standpoint, the designer observed that *EmotiToon* integrates coherent and purposeful interactions that align with its educational goals, believing that there is a good balance between fun and learning.

A particularly noteworthy point raised was the design of the sticker notebook, which she appreciated for its role in reinforcing emotional understanding and contributing to self-reflection through personalization. As the professional remarked:

"*I find it very interesting that we can add personal information to 'O Grande Livro das Emoções', allowing for the use of the book to go beyond a simple reward support. By enabling the child to add personal information, such as feelings and experiences, the interaction with the book promotes self-expression, creates greater emotional involvement with the game, and helps with reflection on emotions.*"

8.4.2 Perspectives of Mental Health Professionals on the Game

This section presents the thematic analysis of the answers provided by the mental health professionals who participated in the usability assessment. The results were divided into five key themes: 1) Usability, 2) Satisfaction, 3) Emotional learning and development, 4) Practical applications, and 5) Suggestions for improvement. Each theme was further partitioned into subthemes, allowing for a deeper and specific analysis.

8.4.2.1 Theme 1: Usability

This theme explores psychologists' perspectives on the usability of *EmotiToon*, focusing on four key dimensions: ease of use, clarity of in-game instructions, navigation and interface design, and overall gameplay experience.

Ease of Use

After experiencing the full game, all psychologists agreed that it was easy to play. However, some aspects were pointed out that could be improved to make the gameplay even more intuitive.

For instance, participant 2 perceived some difficulty when starting each different level, stating that it's not intuitive. Similarly, participant 1 mentioned that they were left "*waiting to see if something would happen*", suggesting a need for a clearer indication of progression.

Despite these observations, the overall perception of usability was highly positive, with psychologists reinforcing that the game was clear and not complicated, One participant [participant 3] explicitly stated that the game featured "*simple and intuitive controls [...], clear objectives, and immediate feedback*", highlighting a smooth user experience.

Clarity of Instructions

While the instructions were generally viewed as clear and easy to understand, this was the most frequently mentioned area for improvement. When psychologists were asked whether they considered the game instructions appropriate for children, all participants responded affirmatively, except for participant 4, who expressed that, for the target age group, the instructions were not sufficiently explicit. Participant 3 further elaborated: "*It might be helpful to have detailed instructions at the beginning; the mechanics are not always explained - at times it's unclear what action is expected (e.g., click, drag, avoid), which leads to trial and error. This can be frustrating, especially if there is no clear feedback on the mistakes.*".

Moreover, the same participant suggested the inclusion of "*a brief initial tutorial with practical examples and symbolic explanations of each emotion/character*", which could help make the player experience more fluid from the beginning. In contrast, another psychologist [participant 2] highlighted the usefulness of the audio instructions, which made the experience easier to follow.

Navigation and Interface

With the objective of better understanding whether the game's design was appropriate, psychologists were asked about the navigation across game sections, the visual design, and the interface.

There was a consensus that navigation was simple and user-friendly, with participant 5 specifically acknowledging the use of padlocks to signal which levels had not yet been played. Participant 1 suggested an improvement for this area, recommending "*highlighting the next step with a blinking arrow, for example, to avoid the risk of replaying the same scene by mistake.*".

Furthermore, participant 3 particularly praised the interface, describing it as "*very clear and visually clean*", with "*well-placed and visible buttons, and a logical flow*". This professional continued by suggesting the inclusion of an option to go back or repeat levels, along with a map or progress bar, to help players stay oriented and better manage their expectations. Additionally, feedback from participant 1 further reinforced this idea, proposing the integration of an arrow icon prompting the user to click and advance the narrative, which would improve clarity.

Although some modifications can still be made, all psychologists agreed that the game's design and interface were well-suited to facilitate navigation for children.

Gameplay

All participants played the game on a computer. While the overall gameplay experience was described as positive, three out of five psychologists identified minor inconsistencies or unexpected behaviors during the game.

Participant 1 noted that one part of the game advanced too quickly and commented that some of the voice lines occasionally sounded unnatural. Participant 2 reported an issue during the mini-game '*Reciclagem da Raiva*', where the tutorial hand remained frozen on the screen, preventing further progression. Similarly, Participant 5 experienced a problem in the mini-game '*Canos dos Pensamentos*', where the game congratulated the player despite the task not having been completed.

The remaining two psychologists did not encounter any technical problems or irregularities and completed the game smoothly. Despite the isolated issues, the feedback suggests that the game generally functioned well.

8.4.2.2 Theme 2: Satisfaction

This theme explores the psychologists' overall satisfaction with the game, focusing on their general impressions, the game's capacity to engage and retain interest, and the appeal of its core elements. Additionally, it highlights both the features most appreciated by professionals and the aspects identified for potential enhancement.

General Impressions

When asked about their general impressions of the game, all psychologists expressed very positive opinions. Participant 1 described the game as "*very good, very interactive, well-constructed, made me want to keep playing to the next level*," while participant 4 highlighted that "*it has appealing visuals, which facilitates children's motivation to play*". Participant 3 elaborated in more detail, stating:

"*My overall impression of the EmotiToon game is very positive. It is a playful, accessible, and visually engaging proposal with strong educational potential, particularly in the field of emotional literacy. Through simple mechanics and expressive characters, the game manages to engage players in recognizing basic emotions in a non-intimidating way, which is ideal for children and adolescents, including those in more vulnerable contexts, such as residential care.*"

When asked what they liked most about the game, psychologists mentioned its simplicity, realistic exercises, interactivity, and the way correct answers were reinforced and contextualized. Participant 2 specifically highlighted game elements such as identifying emotions through a puzzle, the mini-games '*Reciclagem da Raiva*' and '*Reconstruir a Amizade*', noting how the latter promotes union and help through drag-and-drop of items. Furthermore, another psychologist [participant 3] added that what they liked the most about the game "*was its playful and accessible approach to emotional recognition, using expressive and friendly characters that easily capture*

attention". This professional also explained that "*the colorful, welcoming aesthetics combined with simple mechanics create a safe and engaging environment, ideal for adolescents who might struggle to talk about emotions directly*".

Regarding less positive aspects, some psychologists reiterated the need for clearer instructions, in a way that makes evident what is expected of the player, without generating moments of confusion. Moreover, participant 1 disliked "*having to keep clicking the screen to move to the next line*", while participant 4 mentioned a desire for more feedback for the child throughout the game. Other suggestions for improvement included adding "*a brief explanation of what joy is*" [participant 2], "*some complexity within each level*" [participant 3], and "*making characters' faces change according to emotions*" [participant 5].

Interest and Repetition

All professionals agreed that the game successfully captures children's interest and attention. They also believed that children would want to play the game more than once, in particular with one psychologist [participant 1] justifying this by describing the game as "*very well designed, appealing, and interactive*". Participant 5, on the other hand, believes this replayability would happen "*only if they couldn't successfully complete all the challenges and felt like trying again*".

When asked directly whether they believed children would enjoy playing *EmotiToon*, all psychologists responded affirmatively.

Game Elements

When analyzing the responses of each participant, it became clear that all professionals greatly appreciated the characters included in the game. Participant 3, who previously identified the characters as one of the game's best features, explained:

"*The EmotiToon characters are visually appealing, colorful, and have clearly defined facial expressions, making them easily recognizable and emotionally accessible.*"

Another psychologist [participant 4] suggested the inclusion of "*characters from an animated film for this age group*". Still, all participants believed children would relate to the existing characters.

Regarding the reward system, the notebook with the stickers generated some mixed opinions. While three psychologists found the sticker album motivational for children, participant 1 argued that "*a points system could be more effective*," and participant 2 proposed enhancing the feature by making the sticker album more visible at the end of each level to reinforce the reward mechanism.

8.4.2.3 Theme 3: Emotional Learning and Development

This theme addresses the game's effectiveness in supporting emotional learning, examining how well emotions are represented, the extent to which ER strategies are promoted, and whether the game encourages self-reflection and emotional growth in children aged 6 to 9.

Emotional Representation

Given the game's core objective of promoting emotional education, it was essential to assess professionals' perceptions of how well emotions were selected and represented. All psychologists agreed that the emotions included in the game were appropriate and effectively depicted. Participant 3 emphasized:

"*The emotions addressed in the game were well chosen, focusing on the most common and relevant basic emotions for childhood. The characters' facial expressions are clear and easily recognizable, which facilitates identification by children.*"

Furthermore, another professional [participant 5] expressed a desire to see the inclusion of "*more uncomfortable emotions such as frustration and failure to achieve a goal*", highlighting that this would allow children to "*train for discomfort, not just comfort*".

Despite the generally positive feedback regarding emotion selection and depiction, opinions varied with respect to the game's ability to support emotion recognition and labeling. One psychologist [participant 3] believed the game had clear potential, especially with basic emotions like joy, sadness, fear, and anger, stating that this was achieved "*through the characters' clear facial expressions and the tasks associated with identifying or reacting to emotions*". In contrast, participant 1 felt that emotional recognition was not the game's strongest point, although it could be achieved with appropriate guidance. Another professional [participant 4] suggested a more direct approach, proposing the inclusion of "*several facial expressions for children to match with each emotion*".

Promotion of ER Strategies

The game's central emotional component lies in promoting the use of ER strategies. According to psychologists, the game succeeds in this objective, with participant 1 even identifying it as the game's strongest point. Only participant 3 offered a more critical perspective, stating that although the game introduces emotional awareness, it only promotes regulation strategies in a limited way:

"*The game is effective in introducing and recognizing basic emotions, helping children identify expressions and link them to names, which forms a fundamental basis for regulation. However, it doesn't directly teach or train strategies such as deep breathing, seeking help, stepping away from situations, or cognitive reappraisal.*"

Since the introduction of these strategies depends on the narrative and context of each scenario, professionals were also asked about their perception of the storylines and emotional challenges presented. The consensus was that these were well-chosen and relevant to real-life situations faced by children, with participant 1 noting these challenges were "*very close to the reality of children in this age group*".

Self-Reflection and Emotional Impact

Another important goal of the game was to encourage emotional reflection and facilitate the transfer of learned emotional competencies into real-life contexts. From the psychologists' point of view, the game's activities help children reflect on their emotions, with participant 1 noting that "*most activities are well connected to the themes being addressed*". Additionally, this psychologist also expressed that "*at times, the connection between the activity and the proposed strategy could be clearer*", suggesting improved framing to help children better understand the purpose. Similarly, participant 3 felt that reflection was encouraged only to a limited extent, noting a lack of "*moments that prompted self-reflection or connections with the child's personal experience*".

Despite these suggestions for improvement, all professionals unanimously agreed that the game contributes to children's emotional development and is appropriate for the intended age group of 6 to 9 years. One psychologist [participant 3] emphasized its value, particularly "*in terms of emotional recognition and naming emotions*", adding that its impact could be even greater "*when used with adult mediation and integrated into complementary activities*".

Furthermore, professionals believe that the game is able to encourage emotional conversations beyond the gaming session, acting as "*a starting point for conversations about emotions*" [participant 3]. Another psychologist [participant 1] added that the game allows for "*the creation of challenges for the child's real context*", offering opportunities to practice the strategies proposed in the game.

8.4.2.4 Theme 4: Practical Applications

This theme considers the practical use of *EmotiToon* in real-world settings. It presents psychologists' opinions on the contexts in which the game is best suited, such as schools, clinical sessions, or at home, and their recommendations regarding how often it should be used to support emotional development.

Contexts of Use

When evaluating the game, it was essential to understand the contexts in which professionals considered it appropriate for use. All health professionals agreed that *EmotiToon* is suitable for various settings, including schools, home environments, and clinical contexts. One psychologist [participant 1] explicitly stated:

"*Without a doubt, I would easily use it in a psychology consultation.*"

Additionally, professionals particularly emphasized the game's usefulness in emotional education sessions or psychological interventions, noting that they would use it as a complementary tool during their sessions and would also recommend it to other mental health professionals.

Frequency of use

Recommendations regarding how frequently the game should be played varied significantly among participants. One professional suggested daily use, completing one challenge per day. Another proposed using the game three times per week, while a third recommended once a week over four to six weeks. Participant 4 explained that the ideal frequency depends on the child's level of emotional awareness:

"*It depends on how easily the child recognizes emotions. If the child has no difficulty, frequent repetition may not be necessary. However, revisiting the game when the child is experiencing a specific emotion they don't know how to handle could be useful.*"

8.4.2.5 Theme 5: Suggestions for Improvement

Two professionals provided suggestions for future iterations of the game. Participant 3 recommended incorporating more real-life scenarios with emotional decision-making and corresponding regulation strategies:

"*It would be useful to add everyday situations with emotional choices and suggestions for regulation strategies. This would make the game more complete and applicable to the child's real life.*"

Participant 4 suggested some specific improvements, such as the inclusion of additional instructions, an alternative mini-game focused more on emotional association than puzzle-solving, and an automatic adjustment of the main character's appearance based on the selected name's gender.

As a final reflection, participant 3 summarized the potential of *EmotiToon* as follows:

"*The game has a very positive and appealing foundation for children, with great educational potential. With small adjustments, such as more emotional context, self-regulation strategies, and a greater variety of situations, it could become an even more powerful tool for children's emotional development.*"

8.5 Conclusions

Even with a reduced number of participants, the usability assessment provided encouraging and valuable insights, with both mental health professionals and the game designer giving positive feedback that exceeded expectations. The participants emphasized that *EmotiToon* has a good balance between entertainment and educational value, presenting an appealing interface and gameplay appropriate for children between the ages of 6 and 9 years old. Furthermore, the overall simplicity of the game and its colorful visual style were also highlighted as key elements to capture children's attention.

Regarding its objective in promoting emotional knowledge, psychologists expressed strong agreement with the emotional content selected for the game. Although the game currently includes eight emotions, basic and complex, based on Paul Ekman's theory [53, 54], suggestions emerged

for the inclusion of other emotions present in children's daily lives, such as frustration. Similarly, the integrated ER strategies were according to Gross's process model of ER [4], yet some professionals considered that practical and direct techniques were missing, for instance, taking a deep breath or asking for help. Restrictions regarding development time limited the existing range and variety of emotions and ER strategies, but future iterations can easily expand on this by adding more levels and character expressions to visually reflect new emotional states and intensities.

Although mental health professionals observed great potential in the game for the promotion and teaching of ER strategies, through its well-aligned narrative and interactive activities, opinions varied on the game's ability to support emotion recognition. While some professionals agreed that the game could indeed help children recognize and name emotions, especially through the characters' facial expressions, others saw this as a secondary strength needing further reinforcement.

Additionally, a particularly well-regarded feature was the sticker notebook, which was recognized as both a motivational reward system and an element capable of stimulating reflection. When designing this notebook, expectations were on capturing children's attention and encouraging them to think about the emotions they experience in their daily lives. This goal was well accomplished as professionals praised the notebook for enhancing children's emotional connection to the game. Still, suggestions were made to improve its visibility and integration with other game parts. Currently, the album is only accessible from the level selection menu, and with short animations of the received stickers during gameplay of each level. Both the game designer and psychologists recommended automatically displaying the sticker notebook after the completion of each level, to remind the player of the rewards' significance and encourage them to reflect on their progress. Furthermore, the game designer showed concerns with the sticker attribution system, which grants stickers for the correct path selection. This approach, although intended to reinforce appropriate emotional responses, may inadvertently promote strategic responding over authentic engagement. Therefore, to minimize this risk, the attribution process should be rethought in order to reward effort and reflection. Although the game already includes instructions and tutorials both for the first opening of the game and inside each level, professionals didn't feel that these were clear enough and could cause confusion. Despite efforts to create simple and visual explanations using animated hand gestures and minimal text to allow better understanding for children, this was a choice that caused oversimplification and left professionals feeling that these aids were sometimes too sparse or ambiguous, particularly during mini-games. However, this is a problem that can still be effectively addressed, achieving a balance between simplicity and sufficient instructions. As for the interface, participants praised it as visually clear and clean, offering some suggestions to make navigation and the overall experience more fluid, including, for example, the addition of visual indicators to track progress across levels.

During gameplay, some psychologists reported a few strange behaviors. However, these were isolated incidents and could not be reproduced during debugging, which suggested this may not be inherently related to game code. Even so, more intensive testing could be done in the future to detect and correct any kind of errors, preventing players from encountering such anomalies.

In order to better contextualize the usability findings of *EmotiToon*, a comparison was conducted with two other SGs, *REThink* [35] and *Emodiscovery*[45], identified in the systematic review that also focused on ER for typically developing children and included usability assessments. The evaluation methods employed in the three games vary considerably, posing challenges to direct comparison. While *REThink* adopted a quantitative approach using validated instruments, such as the Serious Game Evaluation Scale (SGES), to assess multiple usability dimensions, *Emodiscovery* employed quantitative performance metrics (e.g., accuracy, response time, score) and qualitative feedback (e.g., enjoyment, improvement ideas). Furthermore, both games performed the study with a large sample of children and no other groups of participants, tracing a clear distinction from *EmotiToon's* methodology, which involved qualitative feedback from mental health and game design experts. Results from these two games included positive responses regarding narrative engagement and educational relevance, aligning with the professionals' opinions about *EmotiToon*. Similarly, children's high interest and enthusiasm showed during the second phase of co-design in this project, which agrees with the positive engagement observed in *Emodiscovery*. However, children who tested this last game recommended improvements to the game's graphics and audio features, whereas professionals and children evaluating *EmotiToon* praised its colorful cartoon visuals and the inclusion of voices. This indicates that the developed game in this project may be better position in terms of visual design quality and sensory engagement. Furthermore, a feature such as the sticker notebook, supporting both motivation and emotional reflection, is an innovative aspect in *EmotiToon* that is not present in other games.

To conclude, the game's real-world applicability was strongly validated, as all psychologists reported that they would use *EmotiToon* in clinical settings and recommend it for use at home and in schools. The game was recognized as an effective support tool for psychological consultations and emotional education sessions, which, with the integration of the suggested refinements, further strengthens its pedagogical impact for emotional understanding and regulation in children. Table 8.2 summarizes all the planned improvements for a future subsequent iteration of *EmotiToon*, taking into account the game designer and psychologists' feedback.

Table 8.2: Summary of planned improvements for future iterations of *EmotiToon*

Area	**Identified Problem**	**Origin of the Feedback**	**Proposed Improvement**
Beginning of the levels	Unintuitive start, lack of clear instructions on how to progress in the story	Game designer, psychologists	Add a 'Next' button or a visible arrow icon, always present, to move forward with the dialog
Interface	Low contrast buttons	Game designer	Change the color of all buttons to colors not used in the background images
Game instructions	Instructions are not always clear and accessible	Game designer, psychologists	Add a 'Help' button in the levels menu that provides instructions and tutorials for the game's main mechanics and features
Level instructions	Lack of orientation, especially during mini-games	Game designer, psychologists	Add a 'Help' button inside each mini-game that, when clicked, shows the animated tutorial again; Automatic replay of the tutorial after a failed attempt, or X seconds without any attempt
Level selection menu	Lack of a progress indicator	Game designer, psychologists	Use different icons to distinguish between an unlocked level that has not been played yet and a completed one
Sticker attribution	Linked exclusively to the right answer	Game designer	Each answer given (even if incorrect) generates points, which, after X points, unlock a sticker
Notebook	Poor visibility after completing a level	Game designer, psychologists	Automatically show the notebook as soon as the level ends, with a short animation highlighting the new stickers received
Character selection menu	No visual confirmation of the choice made	Game designer	Add a 'Save' button to save all changes made in the character selection menu
Audio and voices	Some voices sound strange	Psychologists	Record dialogue lines with real people, instead of using AI voices
Emotional representation	Some important emotions, such as frustration, were left out	Psychologists	Include new emotions in upcoming levels

Chapter 9

Discussion

9.1 Discussion

This dissertation aimed to develop a SG to support the acquisition of emotional knowledge and ER skills in school-aged children. Based on this objective, three research questions were formulated to guide the investigation across the design, implementation, and impact of such a game.

Q1: What are the key game design elements for adapting emotion regulation into serious games for children aged 6 to 9 years old?

This research question was first addressed through a systematic literature review, which analyzed existing SGs developed for children with a focus on ER. The review explored topics, including design elements, such as concept and storyline, game mechanics, intended platforms, technologies used, and the inclusion of instructions and tutorials. Although the number of relevant studies was limited, a number of recurring design elements were identified that contribute to effective emotional learning. These patterns included the use of immersive and relatable narratives, decision-making mechanics, progressive difficulty structures, rewards based on coins, points, or unlockable elements, and interactive tasks, employed to improve motivation while reinforcing positive learning.

These insights were then complemented and refined through the first phase of co-design involving mental health professionals. Their contributions aligned with results from the literature, highlighting the importance of narrative, realistic scenarios, rewards, and challenges. In addition, professionals recommended including emotional challenges/dilemmas and characters that children could relate to.

These elements were implemented into the final version of *EmotiToon*, in addition to the visual representation of basic and complex emotions, and mini-games specifically linked to ER strategies.

Q2: Can a serious game improve accessibility, engagement, and ease of use of emotional learning interventions in contexts such as schools?

During the interviews in the first co-design phase, psychologists shared their views on the current emotional support in school, as well as the role of technology, in particular SGs, in educational settings. These professionals stressed that there is a lack of resources to address students' emotional needs and positively reacted to the idea of SGs as accessible and engaging tools.

In the second phase, conducted for prototype testing, a small group of children played the first level of the game as an educational activity during a school course, showing great interest and engagement, further supporting the game's potential to combine learning with entertainment.

Finally, in the usability assessment, professionals from both mental health and game design evaluated the game, with all highlighting the simplicity and interactivity of the mechanics, as well as their alignment with the emotional objectives and ages of the target audience. Moreover, psychologists underlined the game's suitability for use in clinical, school, and home settings, once more confirming its accessibility and ease of use.

Q3: How can a serious game contribute to the emotional development of children aged 6 to 9 within school-based or therapeutic environments?

While the game could not be formally tested with the target population, results from the usability assessment conducted with psychologists revealed that *EmotiToon* can be effective in supporting emotional development in children, particularly in terms of promoting ER and, to a lesser extent, emotion recognition. This was achieved through a careful game design that included the representation of emotional challenges based on real-life situations, requiring the player to identify and manage emotions by applying the appropriate ER strategies. These strategies were directly inspired by Gross's process model of ER [4], which ensures a strong theoretical foundation for in-game content.

Furthermore, professionals highlighted the relevance of the sticker notebook as both a motivational and reflective element that contributes to emotional development. This notebook allows children to complete personalized activities about each emotion, which promotes self-expression and can spark emotional conversations outside of gameplay, thus supporting the transference of learning to real-life situations.

In summary, although a large-scale experimental testing could not be conducted as originally envisioned, for not having received the approval of the Ethics Committee, the research questions were nonetheless addressed through a combination of literature review, expert collaboration, prototype testing, and usability evaluation. The study contributed to identifying essential design elements for SGs targeting emotional competencies, confirmed the potential of such games to enhance accessibility and engagement in educational settings, and provided evidence of their value in promoting emotional development. These findings serve as a basis for future empirical validation and further development of SGs as tools for emotional education in childhood.

9.2 Conclusions

This dissertation arose from a serious concern regarding emotional education for children, in particular, the lack of accessible tools for teaching ER skills to school-aged children. To address the identified problem, this dissertation proposed the development of a SG for the acquisition of ER competencies for children between the ages of 6 and 9 years old.

This study started with the establishment of a theoretical background, exploring psychological and SGs literature to better understand the concepts in question, and also serving as a basis for the game development. This research heavily inspired the game's emotional component to follow Gross's process model of ER [4] and Ekman's emotions theories [53, 54] , widely adopted in the field of mental health. This research was preceded by a systematic review, which provided a comprehensive overview of existing SGs targeting ER for younger populations, exploring the current state of the art and gaps that could later be addressed by the game to be developed. After having a clear understanding of the subject and existing solutions, a carefully structured methodology was planned that integrated co-design principles to ensure a design centred on the needs of its intended users. While the literature review revealed that some studies included multiple stakeholders besides the target population, this constituted a small part of the research body, with some not even involving them in the design process. With the proposed methodology in this study, children, their parents, teachers, and mental health professionals would play an important role in three crucial phases: conceptual design, prototype testing, and final usability testing.

Despite outlining a complete plan for the development process, the study still faced some limitations, particularly concerning ethical constraints that prevented its full execution. A request for the study's approval was submitted to the Ethics Committee, but no answer was received, causing serious delays in the original schedule and reducing the time available for the game development. Consequently, to proceed with the co-design methodology, the group of stakeholders had to be rethought to include only participants involved with the research through LIACC. This led to a small sample size for all three phases, with little involvement from children and mostly relying on psychologists' opinions, resulting in a lack of diversity in the gathered perspectives. Consequently, the game was not formally tested with its target audience, thus restricting empirical evidence regarding its emotional impact. As the game's impact on children's ER skills could not be assessed objectively, it exclusively depended on the perception of the mental health professionals participating in the usability assessment. Although the game was considered suitable for various contexts, the validation only took place in a clinical context with psychologists, and there is still a lack of practical evaluation of its use in schools or at home. Another limitation resulting from the ethical constraints was the absence of standardized instruments in the usability test. Whilst a qualitative approach based on open questionnaires was used, not applying validated scales makes direct comparisons with other similar studies difficult.

In spite of the encountered limitations, the co-design methodology remained closely aligned with its original objectives, providing valuable insights that were integrated into the game development. In particular, the first phase proved to be a crucial step in defining the game elements,

including the concept, scenarios, characters, and mechanics, while the second yielded insights into appreciated features and needed improvements. Additionally, the third phase, corresponding to the usability assessment, provided validation of the game's usability, appeal, and educational potential, and included participation from professionals in health and game design. Psychologists showed high acceptability of the game, recommending its usage across multiple settings, such as clinical contexts, schools, and home environments. Furthermore, the feedback from this phase also served to delineate a plan for future development iterations, with the possibility of expanding the game to include additional levels, emotions, and regulation strategies.

Beyond the development of a SG, this dissertation holds significant theoretical and practical contributions. The completed systematic review advances the field of ER for children by reviewing, systematizing, and critically analyzing existing SGs. Moreover, *EmotiToon* was developed based on a strong theoretical foundation, particularly inspired by Gross's process model of ER [4] and Ekman's classification of emotions [53, 54], ensuring psychological accuracy and relevance. Additionally, the SG was recognized as a valuable tool to support emotional education in children, and with vast applications. Methodologically, this work offers a structured and replicable approach for a user-centered development of SGs, clearly outlining phases, stakeholder involvement, and instruments, even when limited by external constraints. Ultimately, the process of scientific divulgation conducted during this research, through public presentations and participation in conferences, contributed to increasing awareness of the topic and enhancing the visibility and impact of the work within both academic and professional communities.

9.3 Future Work

Regarding future work, it is essential to repeat the usability assessment, with a larger and more diverse sample, including not only mental health professionals but also children, their parents, and teachers. With a vast group of participants, the collected data will reflect different perspectives on the usefulness, satisfaction, and applicability of the game. At the same time, an experimental study should be conducted to assess the game's effectiveness in improving children's ER skills. This study would involve pre- and post-intervention assessments using validated instruments, allowing for an accurate measure of potential changes in children's emotional awareness and regulation after interacting with the game over a defined period.

Regarding the game's development, it is crucial to incorporate the improvements suggested during the usability testing phase, including clarifying instructions, refining the user interface, and adjusting the reward system to prevent strategic or artificial responses. Finally, future versions of the game could be expanded with new levels, introducing more complex emotions in varied everyday scenarios. Besides ER strategies, the game could also include relaxation and mindfulness techniques to help children develop a broader knowledge of how to deal with emotional situations.

These proposals not only improve the current version of *EmotiToon* but also solidify its position as an educational and therapeutic tool capable of supporting emotional development in younger populations.

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Appendix A

Scientific Divulgation

A.1 A Systematic Review of Serious Games for School-Aged Children

This systematic review aims to investigate existing SGs aimed at ER in children, exploring how they are designed, implemented, and evaluated in educational, psychological, or therapeutic contexts. The findings from this review are presented in the chapter 3 of this dissertation.

Title A Systematic Review of Serious Games for School-Aged Children
Authors Bárbara Carvalho, Eliana Silva, and Luís Paulo Reis

A.2 XII Congresso Internacional de Psicologia e Educação

The International Congress of Psychology and Education serves as a scientific forum exploring themes around psychological well-being, development, learning, and the challenges of digitalization in education. For this congress, we submitted an abstract that was later accepted. Due to travel difficulties for the face-to-face presentation at the event and confirmation that a remote presentation was not possible, we decided not to submit the full paper.

Location Palacio de Exposiciones y Congresos de Oviedo, Asturias, Spain (from June 25th to 27th of 2025)
Title Emotion Regulation in Children: A Co-Designed Serious Game Approach
Authors Bárbara Carvalho, Eliana Silva, and Luís Paulo Reis

A.3 13th International Conference on Serious Games and Applications for Health

The SeGAH conference focuses on the design, development, and use of serious games and applications for health, committing to advance the field through innovative solutions and technologies. For this conference, we submitted a full paper covering the key design elements of SGs targeting

ER for children, based on the previously mentioned systematic review. The paper was accepted and resubmitted with the modifications advised by the reviewers.

Location Manchester Metropolitan University, Manchester, UK (from August 6th to 8th of 2025)

Title Serious Games for Emotion Regulation in Children: A Systematic Review

Authors Bárbara Carvalho, Eliana Silva, and Luís Paulo Reis

A.4 19th European Conference on Game Based Learning

The ECGBL conference brings together researchers, educators, and practitioners to explore how games and technology can enhance learning. For this conference, an abstract was first submitted to present the protocol followed by this dissertation to develop the SG, discussing the co-design phases. After its acceptance, a short paper and a poster were submitted and accepted.

Location Nord University, Norway (from October 1st to 3rd of 2025)

Title A Co-Design Protocol for a Serious Game Supporting Emotion Regulation in Children

Authors Bárbara Carvalho, Eliana Silva, and Luís Paulo Reis

A.5 Encontro de Investigação Jovem da U.Porto

The IJUP scientific meetings are annual events where U.Porto students have the opportunity to present and discuss the results of studies in which they have participated as part of research initiation projects. For this meeting, a poster was developed and presented to showcase the results from the first co-design phase.

Location Abel Salazar Institute of Biomedical Sciences - Faculty of Pharmacy of the University of Porto (from May 7th to 9th of 2025)

Title Emotion Regulation in Children: Designing a Serious Game with a Co-Design Approach

Authors Bárbara Carvalho, Eliana Silva, and Luís Paulo Reis

Appendix B

Co-Design Materials

B.1 First Phase of Co-Design

B.1.1 Sociodemographic Questionnaire

Questionário sociodemográfico (versão para profissionais de saúde)

I. Dados Pessoais

Sexo (coloque um x) Feminino _____ Masculino _____

Idade _____

Nacionalidade _____

Área de formação profissional: _____

Anos de experiência profissional: (indique o número) _____

II. Experiência profissional:

Na sua prática profissional, costuma utilizar alguma nova tecnologia durante as consultas ou intervenções?

Sim _____ Não _____

Em caso afirmativo, que tecnologias costuma utilizar?

_____

Já utilizou jogos digitais ou ferramentas tecnológicas em intervenções para promover a regulação emocional?

Sim _____ Não _____

Em caso afirmativo, que recursos usou?

_____

Figure B.1: Mental health professionals sociodemographic questionnaire

B.1.2 Interview with Mental Health Professionals

O objetivo desta entrevista é obter a sua perspetiva sobre o que devemos incluir no desenvolvimento de um jogo sério para o treino de competências de regulação emocional em crianças de idade escolar (6 a 9 anos), assegurando que o jogo é adequado a este público-alvo.

1. Quais são as dificuldades emocionais mais comuns em crianças nesta fase de desenvolvimento?
2. Nota alguma emoção que seja particularmente difícil para as crianças regularem como raiva, tristeza ou ansiedade?
3. Em que momentos essas dificuldades costumam surgir?
4. De que forma acha que as dificuldades emocionais impactam a aprendizagem e a interação entre as crianças?
5. Que estratégias ensina às crianças para ajudar a lidar com emoções intensas?
6. Acha que existe uma maior necessidade de apoio emocional nas escolas?
7. Está familiarizado/a com o conceito de "jogos sérios" (jogos com objetivos educativos ou terapêuticos)?
8. Qual a sua opinião quanto à utilização de novas tecnologias para fins educativos ou terapêuticos?
9. Qual a sua opinião quanto ao acesso das escolas e famílias a ferramentas tecnológicas, como jogos sérios, para crianças?
10. Qual a sua opinião sobre o desenvolvimento de um jogo sério para o treino de competências de regulação emocional em crianças?
11. Como considera que estas competências podem ser promovidas num contexto de jogo?
12. Que cenários ou histórias devemos incluir que sejam envolventes e motivadoras para crianças entre 6 e 9 anos?
13. Que tipo de personagens acha que seriam mais adequados para o jogo?
14. Qual seria um bom ambiente ou contexto para o jogo?
15. Que tarefas ou atividades devem existir no jogo que ajudem no reconhecimento das emoções e no treino de estratégias de regulação emocional?
16. Que tipo de estratégias podemos integrar para assegurar que os objetivos do jogo sejam alcançáveis e motivadores para as crianças?
17. Que tipo de recompensas considera adequadas para motivar as crianças neste jogo?

18. Qual é a melhor forma de fornecermos feedback às crianças sobre o treino de estratégias de regulação emocional?
19. Como acha que podemos garantir que a experiência de aprendizagem seja desafiadora, mas alcançável para as crianças?
20. Que tipo de escolhas devemos dar às crianças durante o jogo para incentivar a autonomia e a tomada de decisões emocionais?
21. Que plataforma acha mais adequada para o jogo ser jogado por crianças? (ex.: telefone, pc, tablet)
22. Para concluir, tem mais algum comentário ou sugestão para o jogo?

B.2 Usability Assessment

B.2.1 Questionnaire for Mental Health Professionals

O objetivo deste questionário é obter a sua perspetiva sobre o jogo, com foco na eficácia e adequação a crianças e sugestão de melhorias.

Usabilidade do EmotiToon

1. O jogo foi fácil de jogar?
2. O que tornou isso fácil ou difícil?
3. Teve alguma parte do jogo que achou complicada ou confusa? Se sim, explique por favor.
4. As instruções do jogo estavam claras e fáceis de entender?
5. Considera o design e a interface do jogo adequados para facilitar a navegação das crianças?
6. Considera que as instruções do jogo são claras e fáceis de seguir para as crianças?
7. A navegação entre as partes do jogo foi simples? O que poderia melhorar?
8. Notou alguma inconsistência ou algo estranho no funcionamento do jogo?
9. Em que dispositivo foi jogado o jogo (ex: telemóvel, tablet, computador)?

Satisfação com o EmotiToon

1. Qual foi a sua impressão geral sobre o jogo?
2. O que mais gostou no jogo?
3. O que menos gostou no jogo?
4. Sentiu falta de alguma coisa no jogo?

5. Considera que o jogo desperta o interesse e atenção das crianças?
6. Acredita que as crianças teriam vontade de jogar este jogo mais do que uma vez?
7. Qual a sua opinião sobre os personagens incluídos no jogo? Acha que as crianças se identificam com eles?
8. Acha que o sistema de recompensas (ex.: caderneta com autocolantes para colar) é motivador para a criança?
9. Considera que as crianças gostariam de jogar o EmotiToon?

Aprendizagens e Desenvolvimento Emocional com o EmotiToon

1. Considera que as emoções abordadas no jogo foram bem escolhidas e representadas?
2. Considera que o jogo promove de forma adequada o uso de estratégias de regulação emocional?
3. Considera que os cenários e as histórias foram bem escolhidos para refletir desafios emocionais comuns enfrentados pelas crianças?
4. Acha que o jogo ajuda a criança a reconhecer e nomear as suas emoções?
5. Considera que as atividades do jogo ajudam as crianças a refletir sobre as suas emoções?
6. Acredita que o jogo contribui para o desenvolvimento emocional de crianças entre os 6 e os 9 anos?
7. Considera que o jogo é capaz de estimular conversas sobre emoções com a criança fora do momento de jogo?

Aplicação prática do EmotiToon

1. Recomendaria o EmotiToon para o uso em casa?
2. Recomendaria o EmotiToon para o uso em escolas?
3. Recomendaria o EmotiToon a outros profissionais de saúde?
4. Com que frequência recomendaria jogar o EmotiToon?
5. Acha que este jogo pode ser útil em sessões de psicologia ou educação emocional?
6. Usaria este jogo como ferramenta complementar durante as sessões de psicologia?
7. Sugestões e Melhorias para o EmotiToon
8. Há alguma funcionalidade ou conteúdo que acha importante adicionar ao jogo?
9. Tem mais algum comentário ou sugestão sobre o jogo?

B.2.2 Questionnaire for Game Designers

Este questionário tem como objetivo recolher a sua opinião enquanto profissional da área do design de jogos, relativamente ao jogo desenvolvido. O jogo intitulado EmotiToon foi criado para crianças dos 6 aos 9 anos e tem como principal foco o treino de competências de regulação emocional, através de narrativas interativas e mini-jogos.

A sua perspetiva técnica será extremamente valiosa para identificar melhorias na interface, mecânicas de jogo e experiência geral de utilização.

1. Considera que as mecânicas de jogo são adequadas à faixa etária (6–9 anos)?
2. As interações propostas são intuitivas e coerentes com os objetivos do jogo?
3. O ritmo do jogo é adequado para manter a atenção e motivação das crianças?
4. Que melhorias sugeriria nas mecânicas principais do jogo?
5. O estilo visual e sonoro está bem adaptado ao público infantil e ao tema das emoções?
6. A navegação no jogo é clara, mesmo para crianças que ainda não sabem ler?
7. A narrativa é envolvente e bem integrada com as mecânicas?
8. A introdução ao jogo e os tutoriais são suficientes para contextualizar a experiência?
9. O sistema de recompensas (ex.: autocolantes) é eficaz para reforçar a aprendizagem e motivação?
10. Há um bom feedback visual para as ações do jogador?
11. Como avalia o equilíbrio entre diversão e a componente educativa no jogo?
12. Que elementos do jogo considera mais interessantes?
13. Que melhorias ou adições sugeriria para otimizar a experiência lúdica e pedagógica?