

TEACHING EMOTIONAL REGULATION AND AWARENESS THROUGH  
A VR-BASED RHYTHM GAME

By

Laura Montenegro Jaramillo

Bachelor in Audiovisual Communications and Multimedia

Universidad de la Sabana, 2013

A Major Research Project

presented to Ryerson University

in partial fulfillment of the requirements for the degree of

Master of Digital Media

in the program of

Digital Media

Toronto, Ontario, Canada, 2020

© Laura Montenegro, 2020

## **Author's Declaration**

I hereby declare that I am the sole author of this MRP. This is a true copy of the MRP, including any required final revisions.

I authorize Ryerson University to lend this MRP to other institutions or individuals for the purpose of scholarly research.

I further authorize Ryerson University to reproduce this MRP by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

I understand that my MRP may be made electronically available to the public.

## **Abstract**

### **TEACHING EMOTIONAL REGULATION THROUGH A VR-BASED RHYTHM GAME**

Master of Digital Media, 2020

Laura Montenegro Jaramillo

Digital Media

Ryerson University

Programs designed to promote social-emotional learning (SEL) in high-school students are increasingly being used in schools to facilitate academic and life success. Among a wide range of skills, these programs teach young students how to identify and manage their emotions (CASEL, 2015). Virtual reality holds increasing potential to support SEL programs given the great interest of adolescents in this technology (Yamada-Rice et al., 2017) and the opportunity it provides to practice these skills in a safe but novel way (Slovák & Fitzpatrick, 2015). Additionally, SEL and emotion regulation schemes based on music listening and rhythmic performance are particularly compelling programming for teens, due to the popularity of music among adolescents, the inherent emotional expressivity of music, as well as our natural ability to parse those emotions (Dingle et al., 2016; Faulkner, 2016). This paper explores the use of VR and music in emotional regulation education and proposes the development of a VR rhythm game that complements self-awareness and self-management learning in schools. The game seeks to help students develop skills such as relaxation techniques, emotional expression, emotional literacy through rhythm gaming and performance.

**Keywords:** social-emotional learning, emotions, emotional regulation, self-awareness, self-management, adolescents, virtual reality, rhythm games

## **Acknowledgments**

I wish to extend my gratitude to all the people involved in the elaboration of this project: my supervisor, Dr. Richard Lachman for his support and guidance. His expertise and mentorship have been crucial in every step of the way and have helped me become a better media professional and researcher; Dr. Kristopher Alexander, for his valuable feedback and motivation; My group partner, Camila Bohórquez for her hard work and friendship; Felipe Moreno, Juan Domingo Alvarez, and all the teachers and volunteers at Coschool for their sincere contribution and their hard work and commitment with Colombian youth; Santiago Sarmiento, for composing and mixing the music used in the game prototype; Carlos Ferro, for his help with 3D modeling; My husband, Mahdi Tounsi for his constant love and support, and his assistance in debugging and programming; And to my family, for their constant encouragement and support in all my endeavors.

## Table of contents

Author's Declaration	ii
Abstract	iii
Acknowledgments	iv
Table of contents	v
List of Appendices	vi
Introduction	1
Literature Review	6
Emotions in Adolescence	6
Self-awareness and self-management	6
Emotions	7
Identifying and understanding emotions	8
Emotional regulation	9
Emotion regulation strategies	10
Experiential learning	13
The use of music for emotional learning	13
Technology for emotional awareness and regulation	16
Serious games	16
Virtual reality	18
Methodology	21
Empathize	21
Define	24
Ideate	24
Prototype	26
Analysis	31
Appendix A - First prototype	33
Appendix B - Second prototype	34
Appendix C - Third prototype	35
Bibliography	37

## **List of Appendices**

Appendix A - First prototype	33
Appendix B - Second prototype	34
Appendix C - Third prototype	35

## **Introduction**

Over the last decades, educational curriculums in middle schools and high schools have changed in order to prepare students for the challenges of the 21st century. In today's ever-changing society students need more than the traditional academic competencies to thrive as professionals and citizens. The World Economic Forum has identified ten competencies and character qualities, additional to the foundational literacies that are necessary to fix the skills gap the world is currently facing. These competencies, developed through Social Emotional Learning (SEL), define how students face complex challenges and how they approach their changing environment (WEF, 2016).

SEL is defined as the process to “acquire and effectively apply the knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions.” (CASEL, 2015). Thus, SEL-based programs promote the development of five interrelated sets of cognitive, affective, and behavioral competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision making. Different SEL programs have been designed and implemented around the globe, and take many names, including but not limited to ‘mental health promotion’, ‘emotional literacy’, ‘emotional intelligence’, ‘resilience’, ‘life skills’ and ‘character education’ (Weare & Nind, 2011)

Social-emotional skills (SES) contribute to the construction of well-being among communities. SEL equips young students to act with internalized beliefs and values, care for others, make good decisions, and take responsibility for their actions. They have also been found to help prevent risky behaviors in adolescents such as substance abuse, bullying, interpersonal violence, and school failure (Durlak et al., 2011). The Perry Preschool Study showed that

individuals who had curriculums that incorporated SEL in preschool had higher earnings later on as workers, were more likely to be employed, committed fewer crimes, and were more likely to complete high school (Schweinhart, 2003; WEF, 2016).

Many of the competences promoted by SEL comprise the development of emotional skills. Prevention interventions that look to reduce mental health issues and improve emotional wellbeing from a young age set the grounds for emotional abilities at a later age (Goleman, 2006) and are important contributors to good health and social outcomes. In communities affected by poverty, where inequality and poor health are directly related, wellbeing and mental health play a crucial role (Friedli, 2009). All these outcomes highlight the importance of embedding SEL into core curriculums, particularly in developing countries.

Digital tools can support SEL in key aspects teachers and curriculum designers usually struggle with and introduce novel approaches to its methodologies (Slovák & Fitzpatrick, 2015). SEL programs are more likely to be successful if they emphasize in acquiring skills through active classroom methodologies, including experiential learning, classroom interaction, games, group work and simulations (Durlak et al., 2011; Weare & Nind, 2011), and technology can be a useful tool for teachers to introduce active forms of learning in the classroom. The effectiveness of these programs depends largely on the quality of the implementation and requires intensive training for staff members (Weare & Nind, 2011). Technology can also tackle these problems, giving educators bespoke high-quality tools that help them impart these skills.

Furthermore, recent developments in human-computer interaction (HCI) have shown to promote the use of skills learned in SEL classes in everyday settings by extending the learning process to other situations and involve the student's parents and peers. Technology also aids in the development of reflective skills by enhancing training in emotional awareness, mindfulness



and relaxation and communication skills. Additionally, mixed reality provides opportunities for practicing self-control, perspective taking, communication and collaboration through a wide range of novel situations, with greater autonomy and in a safe way (Slovák & Fitzpatrick, 2015).

Virtual reality (VR) has gained popularity in school settings because of its rapid expansion, and because its unique technological characteristics (e.g simulation, immersion, intuitive interaction and multisensory channels) have been related to positive learning outcomes (Mikropoulos & Natsis, 2011; WEF, 2016). Moreover, games hold great potential for improving specific skills, given that they provide the opportunity to practice and train emotional skills through authentic emotional experiences and allow a personalized approach that traditional imparting methods usually can't offer. Games and virtual reality alike are also effective in motivating and growing an interest of young people in participating in these kinds of programs (Scholten et al., 2016; Schoneveld et al., 2016; Villani et al., 2018).

Nonetheless, there are limitations to using technology in SEL and in education in general that need to be taken into account for a successful implementation. Teachers understand the importance of SEL, yet they don't understand which technologies to use or how to use them, they don't prioritize the use of these tools for SEL, have concerns regarding the monitoring of the content, financial costs and using the technology in a safe way (Cooper et al., 2019; WEF, 2016). The adoption of education technology is also affected by technological and infrastructure issues, inadequate supply of programs and products, and low levels of funding due to a lack of agreement in assessing implementation and measuring results. Global and country-level organizations are mobilizing the agenda towards policies and educational reforms that help face these challenges in a near future. Educators, parents, investors, researchers, businesses, technology developers, and grassroot organizations are coming together to implement different

strategies that facilitate access, implementation and production of educational technology and SEL (WEF, 2016). Based on this, it seems more relevant than ever to direct our efforts towards the research and development of innovative and viable tools for SEL programs.

Indeed, schools and organizations in developing countries are implementing SEL and looking for ways to support it through ed-tech. This is the case of Coschool, a Colombian organization that seeks to improve the mental, physical and social well-being of Colombian adolescents through the development of SES (F. Moreno, personal communication, January 27, 2020). Coschool's experiences and needs seemed a perfect starting point to further explore use and elaboration of relevant digital tools for SEL.

Based on their needs, their input and research on current uses of technology for emotional wellbeing, we looked for SEL methodologies that could maximize the learning processes of two skills in particular, self-awareness and self-management, and that could be enhanced by virtual reality and gaming. The use of drumming and music for SEL caught our attention because of the popularity and effectiveness of these methods among adolescents and their experiential approaches, that aim to facilitate emotional awareness, expression and regulation involving music listening and performance (Dingle et al., 2016; Faulkner, 2016; Pellitteri, 2005). This approach was the starting point of a digitally-mediated tool that not only implemented music as a metaphor for emotions, but embodied music performance in a three dimensional world to facilitate emotional learning.

This major research project aims to explore how VR and music-based games can be used to teach self-awareness and self-management to teenagers. Using a design thinking methodology, this project seeks to define the needs of educators and students when addressing these skills and to review the pertinent literature in emotional education methodologies and emerging

technologies in order to ideate and prototype a VR-based serious game that supports current social-emotional learning processes.

## **Literature Review**

### **Emotions in Adolescence**

Adolescence is a period of rapid physical, emotional, and cognitive growth. This makes SEL especially relevant at this age since these changes offer an opportunity for social-emotional development (CASEL, 2015). Puberty causes changes in the brain structure and hormone activity that modify the way it processes emotions, making minor social problems extremely painful and risky behaviors more thrilling (Yeager, 2017). Adolescents experience major psychological changes as well, including growth in cognitive functioning which is the base of “greater engagement with emotion-relevant aspects of one’s own and others’ existence and future.” (Riediger & Klipker, 2013). Furthermore, adolescents are going through new social and academic demands, while also learning how to deal with new and intense emotions, both positive and negative, with increased autonomy (Yeager, 2017). These challenges make adolescents more vulnerable to being overwhelmed by emotional situations they might encounter.

### **Self-awareness and self-management**

This project focuses on two basic social-emotional competencies, self-awareness and self-management, which reflect the intrapersonal domain. Self-awareness is defined as “the ability to accurately recognize one’s emotions and thoughts and their influence on behavior. This includes accurately assessing one’s strengths and limitations and possessing a well-grounded sense of confidence and optimism.” (CASEL, 2015). Self-awareness is the keystone to self-management, defined as “the ability to regulate one’s emotions, thoughts, and behaviors effectively in different situations. This includes managing stress, controlling impulses, motivating oneself, and setting and working towards achieving personal and academic goals.”

(CASEL, 2015). Knowing and managing one's emotions are the base of emotional intelligence (Goleman, 2006), and are keystones to developing other socio-emotional competences.

Effective SEL and mental health programs focus on the development of relevant skills in students and staff. Most programs tend to offer Cognitive-Behavioural Therapy (CBT) and social skills training to approach internalizing and externalizing problems (Weare & Nind, 2011). CBT is a type of psychotherapy that helps individuals identify and evaluate their automatic thoughts to correct their thinking so it resembles reality more closely, in order to positively influence their emotional, behavioral, and physiological reactions (Beck Institute, 2019).

## **Emotions**

Ekman defines emotion as a process, “an automatic appraisal influenced by our evolutionary and personal past, in which we sense something important to our welfare is occurring”, followed by a set of physiological changes and emotional behaviors that help us deal with the situation (Ekman, 2007). Emotions produce changes in our brain and in our autonomic nervous system, which controls our heart rate, breathing, sweating, among other physical reactions, to prepare us to deal with what triggered the emotion and act accordingly, for example fleeing or fighting when there is a threat. They also generate involuntary changes in our expressions, voice, face, and posture (Ekman, 2007). Furthermore, emotions influence our decision making, determine our behavior in the face of an event, impact our social interactions, and improve our episodic memory (Gross, 2013), making them helpful mechanisms when relating to others.

## Identifying and understanding emotions

Goleman (2006) defines self-awareness as the “ongoing attention to one’s internal states”, a self-reflexive non-judgemental awareness of our emotions. It is the ability to identify and name the emotions aroused and allowing self-awareness of what is happening rather than being immersed in it, even amidst turbulent or passionate emotions. Monitoring our feelings is the first step towards gaining control over them, in other words, self-management. The realization of what we are feeling at a given situation (e.g. “I’m feeling anger”) gives us the possibility to act on it and to let go of it.

Ekman calls this type of consciousness as being *attentive* and it consists of observing ourselves while we are experiencing an emotional episode and recognizing it. This mental exercise allows us to reconsider and reappraise our reactions. If after this we still think our emotions are justified, then we can control what we say and do in a constructive way and not in a way we would later regret. We can become more attentive to our emotions by becoming more familiar with what triggers them in order to be able to take action once we experience them, by knowing the physiological changes they cause in ourselves and use them as signals of an ongoing emotional experience, and by observing emotional behaviors in others (Ekman, 2007).

Thus, one of the goals of SEL curriculums is to train the ability to differentiate, name and notice changes among emotions, practice internal reflection leading to understanding our own and others’ emotions, and making the distinction between feeling and acting as a consequence of that emotion. Some exercises with students include using cards to signal their mood, use popular stories as examples of emotions and to differentiate variants of one emotion, recognize the physical changes and sensations when experiencing each emotion, associate facial expressions

and body postures with an emotion, detecting how others feel depending on their tone and body language, setting goals and assessing their behaviors (Slovák & Fitzpatrick, 2015).

### **Emotional regulation**

Emotions are natural reactions to events happening around us and are necessary for our survival. Fear protects us from a threat, disgust makes us cautious from something toxic, sadness communicates to others our need for help, anger warns us something is irritating us, etc. (Ekman, 2007). On the same note, Gross (2013) defines emotional regulation as “shaping which emotions one has, when one has them, and how one experiences or expresses these emotions”. Thus, managing emotions does not mean suppressing them, since all emotions, pleasant and unpleasant, have a certain value to us. It does not necessarily mean eliminating all unpleasant emotions to be content all the time either, but not letting negative emotions go rampant, displacing pleasant ones. It means finding balance, feeling the appropriate emotions, and proportional to the circumstance, taking control of our emotional reactions to our benefit, rather than becoming “passion’s slaves” (Goleman, 2006).

Emotional management also entails avoiding extremes, if emotions are completely muted, life can become dull. But when they are too intense and persistent, they might become a pathological problem (e.g. depression or anxiety disorder). People who don’t have this skill are constantly battling with distress, while those who have them can quickly recover from life’s common difficulties and setbacks (Goleman, 2006). Studies show that emotional regulation skills in adolescents are linked to social competences, academic success, fewer internalizing (e.g. depression and anxiety), and externalizing (e.g. aggression) problems, peer acceptance, and status. Conversely, emotional dysregulation is associated with psychopathological problems such as anxiety, depression, and eating disorders. Furthermore, the lack of ability to regulate

emotions, particularly anger, is linked to risky behaviors such as delinquency, substance abuse, and aggression (Riediger & Klipker, 2013).

### **Emotion regulation strategies**

Gross (2013) suggests there are different regulation processes or strategies we can practice once an emotional trigger is in place. *Attentional deployment* refers to directing one's attention to modify one's emotions, including distraction (e.g. going for a walk) and focusing on certain thoughts or memories to induce certain emotions; *Cognitive change* means altering how one thinks about a situation or one's ability to handle it (e.g. thinking "this interview is a chance for me to learn more about the company"). Reappraisal is a form of cognitive change. And lastly, *Response modulation* comprises "influencing experiential, behavioral or physiological components of the emotional response" (Gross, 2013) after experiencing an emotional reaction. Physical exercise and deep breathing are response modulation strategies that influence the experiential and physiological elements of unpleasant emotions. Alcohol, drugs, and food are also used to modify emotional experiences but can have negative effects (Goleman, 2006).

Expressive suppression, or trying to constrain emotional behavior, is also a way of modulating an emotional response, but studies suggest negative consequences for suppression such as depressive symptoms and painful feelings of inauthenticity (Gross, 2013). Lower psychological adjustment is related to not focusing on one's emotions in general, including disengaging from the stressor or one's emotions (e.g. expressive suppression, avoidance, withdrawal), having negative cognitions about the self and the situation, and unregulated release or ventilation of emotions (Riediger & Klipker, 2013). In comparison to children, adolescents are increasingly more capable of understanding emotional situations and implementing more



sophisticated regulatory strategies, such as problem-solving, cognitive distraction, positive self-talk, and reappraisal (Zimmer-Gembeck & Skinner, 2011).

Thus, directing and training students on beneficial emotional regulation strategies are key aspects of SEL curriculums. When it comes to mental health and emotional wellbeing interventions, Weare (2010) argues it is best to have a balance between a universal approach and a targeted approach. Offering mental health prevention to all students helps destigmatize these issues and set socio-emotional skills as a norm. Some of the strategies for emotional regulation taught in these programs are verbal labeling of emotions, exercises to practice the acknowledgment of emotions and their causes, training in techniques to relax and calm down during strong emotional reactions (e.g. muscle stretching and deep breathing) and anger management strategies that combine verbal labeling and relaxation techniques (Slovák & Fitzpatrick, 2015).

Once this universal background is established, students with more specific or extreme difficulties, with or without a clinically definable mental health problem, should be offered targeted, more intensive help. These include children with signs of stress, ADHD, suicide and eating disorders, anxiety, depression, and children who are part of a social group with high-risk mental factors such as those in extreme poverty, refugee and asylum seekers, children from parents with a mental illness, experiencing a family breakdown or bereavement. For children whose problems are mild, early interventions may be sufficient, like group sessions to develop cognitive problem solving and social skills, play-based approaches, nurture groups, and parenting skills development. Children with more complex, critical, or disabling problems should be treated by skilled professionals. Cognitive-behavioral therapy and play-based therapies have been successful approaches in these cases (Weare, 2010).

Additionally, some emotional regulation strategies work better in certain situations. Reappraisal is less effective when emotional intensity is already high (Gross, 2013), for example during rage. Anger acts as a sequence of provocations, where every provoking thought builds on the previous one before this one has dissipated, like waves of arousal. A slight annoyance might end up in rage or even violence if fueled by self-justifications. Thus, one of the best ways to defuse anger is to undermine the inner monologue and arguments that are fueling the emotion in the first place, by reframing or reappraising the situation (e.g. “That driver could have hit me! I can’t let him get away with that” vs. “Maybe he didn’t see me”). This works on moderate levels of anger, but with rage it makes no difference since the person is in a high level of arousal where reason is impaired, facilitating aggression as a response (Goleman, 2006).

When experiencing high levels of anger it is more efficient to ease off the adrenal surge in a setting where it is less likely to encounter a trigger. During this period the person can stop the escalating anger using other emotional regulation strategies such as distractions, doing exercise, or relaxation methods like deep breathing and muscle relaxation. Relaxation lowers the physiological arousal level and distracts from triggers as well. Once anger is cooled off, people can confront the trigger more constructively and assertively (e.g. settle a dispute) and not suppress it (Goleman, 2006).

Relaxation works well for other high-arousal emotions like anxiety, a form of fear, because it brings the body into a low-arousal state. On the contrary, it doesn’t work so well for depression, a low-arousal state. Exercise and aerobics, activities that take the body into a high-arousal state, work better when regulating depression. These techniques seem to work because they shift the brain into a level of activity that is incompatible with its initial state. Achieving a small triumph or success (e.g. finishing a chore), seeing things differently through *cognitive*

*reframing* (an approach similar to reappraisal), helping others in need, and praying are other effective antidotes against depression (Goleman, 2006).

## **Experiential learning**

As mentioned, schools and prevention programs implement different methods to teach these skills, but it is known that skill-based learning works best when it engages learners and uses varied learning styles, is experiential and participative, and it includes behavioral strategies such as identification, practice, re-run, coaching and feedback (Weare, 2010). In contrast to traditional learning, experience-based learning is interactive, collaborative, and uses diverse instruction tools and methods such as project elaboration, multimedia, simulations, games, role-playing, etc. (Hromek & Roffey, 2009). Experiential learning in emotional learning means permitting activities and experiences that arouse emotions such as storytelling, role-playing, drawing, listening and moving to music, allowing students to apply emotional skills and familiarize themselves with emotions (Pellitteri et al., 1999).

## **The use of music for emotional learning**

Given its natural relation with emotions, music is a powerful tool in emotional learning, psychoeducational and clinical interventions. Pellitteri (2005) states that the relation between music and emotion has been explained from evolutionary, linguistic, interpersonal, and neuropsychological viewpoints. Music is present in nature in the form of sound patterns and it is also related to the nonverbal tone quality of speech (i.e. pitch, timing, rhythm, intensity), which conveys the speaker's emotional state. It is known that the parts of the brain that interpret emotions are related to the ones that interpret music. Although studies have shown different results, there is general agreement that music described as stimulative increases arousal in physiological responses (heart rate, respiration, galvanic skin response, etc.) while sedative

music decreases it (Hodges cited in Pellitteri, 2005). As stated previously, these bodily states are directly linked to our emotional states. Because of this connection, music can modify our emotional states by affecting our physiological arousal (Pellitteri, 2005).

This correlation between music and emotions is a key element in music therapy. This type of clinical intervention uses music experiences as mediums to achieve clinical goals such as improvised impulse control, increased verbalization, increased social interactions, and greater self-esteem. Music improvisation is commonly used in music therapy to stimulate emotional expression in a nonverbal form and a way to externalize inner emotional tension to others, given that the acoustic aspects of music imitate the emotional states (e.g. loud music can depict an intense emotion). Music therapy practices can be adapted to teach emotional awareness and regulation skills in schools and prevention programs, providing counselors with a unique basis for non-clinical approaches that foster emotional expression and activation (Pellitteri, 2005).

For example, *Tuned In* is an emotion regulation program designed to train at-risk and mainstream youth in emotion awareness, labeling, and regulation using music listening to evoke emotions. Results showed improvements in measures of these three skills, as well as increased engagement and interest from the students in the program (Dingle et al., 2016).

The *Rhythm2Recovery* model created by Simon Faulkner (2016), used in both educational and clinical contexts, consists of pairing drumming exercises designed to explore life-skills with reflective discussions using a cognitive-behavioral framework. This program uses rhythm as a metaphor for life: the drumming rhythms serve as analogies of human behaviors to increase awareness of habits or routines leading to physical and psycho-social harm and health (e.g. patterns of anxiety and stress vs. patterns of comfort and security), to ultimately break free from destructive habits. Drumming-based interventions that use basic CBT concepts to deliver a

range of socio-emotional outcomes, including emotional control, have proven to be successful for indigenous youth (Faulkner et al., 2012) and at-risk youth (Wood et al., 2013).

Pellitelli (2005) outlines several methods to facilitate emotional learning through music in educational contexts. When used as an *emotional stimulus*, music listening allows students to work on their perceptual abilities by identifying their emotional reactions to it, discussing how they can recognize these affective reactions in themselves. *Using music as an aesthetic experience*, involves exploring emotional reactions to different works of art (visual arts, music, dance, theater), and being aware of their thoughts, sensations, and imagination when engaging with them. When participating in aesthetic experiences students can learn to be open and tolerant to multiple perspectives without judging others' and their own reactions.

The third method is *using music for relaxation and imagery* and it consists of using calm music to assist relaxation techniques such as deep breathing exercises, muscle release activities, and imagery, to help students regulate their emotions, particularly anxious ones. This also teaches the student “how to become more aware of his or her physical cues and of the relation of those cues to emotional arousal, and to learn how to modulate emotional states.” (Pellitteri, 2005). Similarly, the drumming exercises proposed by Faulkner (2016) achieve emotional regulation using variances in tempo and volume to develop regulatory skills. The participants play the drums oscillating from a high tempo and volume to a low tempo and volume several times, discussing how this is similar to going from a high-arousal emotional state to a low-arousal state and the stressors and de-stressors that cause them, ultimately providing the participant with a “template for de-escalation” (Faulkner, 2016).

*Music-making as self-expression* draws on music therapy methods. Counselors can use simple percussion instruments (e.g. drums, maracas, or tambourines) in individual or group

improvisation. While creating music “participants feel the tension release through the sound and can find a cathartic expression of their own emotions within the structure of the song.” (Pellitteri et al., 1999). In a group exercise carried by the same authors, a student was prompted to make music to a particular emotion while the other students had to identify the emotion, thus developing in the students the ability to examine the qualities of a given emotion to express it through sound, as well as emotional perception by listening to the qualities of the music. This type of exercise is particularly effective with students who have limited emotional vocabulary. During the exercise, students tended to describe situations that are frustrating, embarrassing, or disappointing as mere anger. Immediate and impulsive reactions to anger, like fighting, impeded them to be aware of the full range of emotions they were experiencing (Pellitteri et al., 1999). In the same manner, Faulkner proposes a drumming exercise where the participants play the same rhythm through a range of emotional states and each participant must suggest an emotion that is played for 15 seconds (Faulkner, 2016). These exercises introduce emotional vocabulary to students so they can understand and identify several emotions and recognize how they overlap (Pellitteri et al., 1999), applying basic self-awareness skills.

## **Technology for emotional awareness and regulation**

### **Serious games**

In recent years there has been an increasing interest in the use of video games for educational purposes, leading to the use of both off-the-shelf commercial games and serious games, meaning “computer games that have an educational and learning aspect and are not used just for entertainment purposes” (Ma et al., 2011) to teach a wide range of competences. Serious games are being used as innovative delivery methods for mental health problems prevention activities based on self-control and calming down skills.

Video games are suitable tools for fostering emotion regulation and even provide a more effective learning environment than conventional programs because of several reasons. Video games are inherently motivating since they provide children with a strong sense of agency and fun, rewarding them for skills like goal-setting and perseverance. They can engage adolescents that find current imparting methodologies boring, and ultimately improve the intervention outcomes. Moreover, video games provide an opportunity to regularly practice emotional regulation skills by presenting users with emotional experiences, until they are well versed in them and ready to apply them in real-life (Scholten et al., 2016; Schoneveld et al., 2016). In video games, players are constantly being exposed to both positive and negative emotional triggers and because they are able to manipulate different functions, they can directly control these triggers and recover from failure as many times as needed until the goal is achieved. For example, overcoming frustration generated by the difficulty of gameplay or fear derived from an enemy (Villani et al., 2018). In contrast, activities like role-playing and homework assignments are often de-contextualized or don't involve skill training (Scholten et al., 2016).

Personalization in video games allows interventions to be tailored to the student's needs and learning pace. Conventional approaches can't usually do this. Video games allow for a better learning experience by adapting the level of difficulty and reinforcement on skills to the player's progress (Schoneveld et al., 2016). Biofeedback games take good advantage of this feature. These games use interoceptive feedback to detect changes in physiological signals like heart rate levels or brain wave patterns, to determine the player's proficiency at applying regulation strategies during high-arousal emotional states in the game, and reward or penalize them by modifying the game in real-time (Villani et al., 2018). The player's biofeedback signals determine the level of difficulty of the challenge or give the character a power-up, making the

game easier when the player is calmed. These features help the player identify their emotional states (shown through indicators) and how to control them.

For example, in *Dojo* the player has to take a glowing ball through a complicated maze without touching the walls. If the player reduces his or her heart rate, the size of the ball reduces, making it easier to complete the challenge (Scholten et al., 2016). In *Nevermind*, a horror-theme game set in the mind of a trauma patient, a higher heart rate leads to more distressing settings (Lobel et al., 2016). *Mindlight* records brain wave patterns, converting EEG values to graduation in a light that guides the avatar through a haunted house (Schoneveld et al., 2016). In *RAGE-Control*, players need to keep their heart rate at a low level to be able to shoot asteroids (Vaudreuil et al., 2017). In the card game *Champions of the Shenga*, players receive points based on their heart rate variability during a training phase and use these points to buy cards they can use against opponents (Collett et al., 2016). In these games, the player receives previous instructions on how to manage anger, anxiety or frustration through regulation strategies such as deep breathing, positive self-talk, progressive muscle relaxation and guided imagery, which are techniques commonly used in CBT (Collett et al., 2016; Scholten et al., 2016; Schoneveld et al., 2016; Vaudreuil et al., 2017).

### **Virtual reality**

Virtual reality (VR) is increasingly becoming an educational tool for science and social sciences alike, given that its unique technological capabilities and features allow for new opportunities and enhancements in learning (Mikropoulos & Natsis, 2011). In virtual reality, users develop the subjective impression that they are present in a three-dimensional virtual world. These worlds can implement virtual objects to represent abstract ideas, helping users comprehend different concepts, if designed correctly (Salzman et al., 1999).



Furthermore, VR experiences incorporate multisensory interaction channels (i.e., visual, auditory and haptic) that can be used to direct the user's attention and potentially improve learning. VR also benefits from intuitive interactivity through the use of peripheral devices like controllers with tracking capabilities (Mikropoulos & Natsis, 2011). Studies in gaming controllers that allow body movements (like the ones used in many rhythm games) suggest that increased body movement can cause increased engagement. They can also produce a stronger affective experience since body posture is considered "a very good indicator for certain categories of emotions" and "can induce changes in affective states" (Bianchi-Berthouze et al., 2007).

These characteristics of VR systems allow the user's immersion in the virtual environment and increases his or her sense of presence in it, a factor that is related to higher learning outcomes (Mikropoulos & Natsis, 2011). Studies suggest that a greater sense of presence can generate more intense emotions. In a VR study, Riva et al. (2007) identified a reciprocal relation between increased levels of presence and the intensity of emotions like anxiety and relaxation. Similarly, studies have found a relation between physical signs of increased arousal during VR experiences (Caldas et al., 2020; Egan et al., 2016). This relation explains the potential of using VR for gaming experiences and emotional wellbeing.

But VR technology itself doesn't bring improved learning outcomes without the proper learning content and instructional strategy. VR features such as the representational fidelity of the 3D images and immediacy control (the ability to be able to manipulate these objects), enhance usability and psychological factors of learning such as presence, motivation, cognitive benefits, control, active learning and reflective thinking. These factors influence learning

outcomes, but it is crucial to have an appropriate and useful set of tasks for learning to happen (Ai-Lim Lee et al., 2010).

Indeed, VR experiences and games are being used to promote relaxation, stress reduction and emotional regulation and awareness. These applications immerse players in calm and pleasant scenarios where they can practice relaxation techniques or, in a more active fashion, use challenges or mini-games to train emotional regulation (Pizzoli et al., 2019). For example, *GameTeen* is a VR-based biofeedback similar to the classic “whack a mole” game, purposefully designed so some of the player’s hits are inaccurate to increase their frustration. The challenge is followed by two mini-games that train respiration and attention (Rodriguez et al., 2015). In *Deep*, a biofeedback VR experience, players explore an underwater fantasy world, controlling their swimming pace through their breathing (Bossenbroek et al., 2020). Other VR experiences seek to train these skills simulating specific circumstances like job interviews (Villani et al., 2017), risky situations for adolescents (Hadley et al., 2019), or social situations that children with autism spectrum disorder can find hindering (Ip et al., 2018). VR experiences like *TRIPP*, complement emotional regulation with features to facilitate self-awareness. This VR mindfulness application intends to make the user feel calm and focused through breathing exercises, mini-games and personalized imagery, and asks the user to select his or her emotional state before and after the experience, serving as a mood tracking device (*TRIPP*, 2020).

## **Methodology**

The project followed a design thinking process to build an innovative, relevant, research-based tool that could be used by Coschool, and potentially by other organizations in education, to enhance their learning methodologies. Design thinking is a human-centered design process used by teams to develop innovative solutions for unknown problems by integrating the needs of people with what is technologically attainable and economically viable. It is a non-linear iterative process comprising five stages: empathize, define, ideate, prototype and test (IDEO, 2015; The Interaction Design Foundation, n.d.). Due to the length of the program and difficulties caused by the Covid-19 pandemic, the project did not reach the testing stage. Nevertheless, we built a functioning prototype that can be tested in further studies.

### **Empathize**

The design thinking process starts with an empathetic understanding of the user's problems and needs. Through user research tools, designers can gain real insights on the problem that needs to be solved, and its root causes, setting aside assumptions (The Interaction Design Foundation, n.d.). To achieve this, our first step was to hold online interviews with key stakeholders at Coschool. In a first interview with Felipe Moreno, Innovation Director at Coschool, we learned that their approach to foster SES in adolescents is through experiential and project-based learning. The program has been implemented in public high schools in the city of Cali, in Colombia, and involved students in the last three years of high school. During the program, students engage in the creation of innovative social entrepreneurship projects within their communities. Throughout the process, along with dedicated workshops, students recognize their abilities and self-efficacy to contribute to society, strengthening self-knowledge and appreciation, emotion recognition and regulation and self-control. Once these skills are

reinforced, working collaboratively in the projects helps them develop healthy interpersonal relationships, empathy, conflict resolution, communication, and decision making. As a result, students have created social initiatives such as a radio station, a program to prevent teenage pregnancy, a dance school, a robotics research group, orchards, a recycling machine, among others. The students are very interested in activities that involve artistic abilities like dancing, music performances and media creation.

Cali is a city affected by inequality and violence. Although the homicide rate against children and adolescents has declined, in Cali children and adolescents are four times more likely to be murdered than their peers in the rest of Colombia. 80% of the victims are adolescents and 70% of homicides are concentrated in only 5 communes. Girls are the group most exposed to sexual and family violence. Infant motherhood has decreased, but its incidence may double according to the girls' place of residence (Osorio Mejía & Aguado Quintero, 2018). These conditions affect the normal development and well being of children in the short and the long term (Save the Children, 2017).

Later on, we met with Juan Domingo Alvarez, one of Coschool's teachers. Juan Domingo told us the program has considered introducing ed-tech to complement the teacher's activities and lessons during the workshops. The students are highly motivated by courses that use technology. They are digital literates and most of them own a smartphone. Although the use of technology is not the goal itself, teachers see it as a powerful medium to grow the student's interest in the workshops, potentially helping decrease dropout rates. Additionally, teachers have seen aggressiveness, conflicts and bullying among the students. They also struggle to get their attention while working on skills like conflict resolution, self-management, empathy and assertive communication to help resolve these issues.

After doing initial research on SEL, we understood we needed to gain more insights from the educators on approaching emotional awareness and regulation skills, due to their importance when dealing with the issues brought up by Juan Domingo. To do this we sent an online survey to Coschool's educators. We learned the workshops facilitate emotional regulation and awareness through role-play and simulations of emotionally challenging experiences followed by reflections. They also draw on stories, anecdotes, videos, guided meditations and exercises to identify and name emotions. They encourage increasing emotional vocabulary to avoid recurring to primary emotions like happy, sad and angry. They engage in games and challenges that lead to frustration, followed by group discussion. They reflect on body signals and responses to emotions, like breathing rhythm, and regulation strategies. They regulate impulses in activities that demand they only speak when they are holding a totem.

However, teachers perceive students find it hard to focus and engage in passive activities like writing, long reflections, or meditations. Students find it difficult to express their emotions honestly, and to communicate assertively with their parents, teachers and peers, because of fear of rejection and being made fun of. They also have trouble accepting all emotions without judging them, especially those seen as "negative". Teachers agree it is necessary to emphasize empathy, conflict resolution, self-knowledge, self-control, emotional literacy and awareness without self-judgment. Also, teachers need to be constantly reminding them to apply SES to interiorize them.

Felipe shared with us the organization's technology strategy, where they plan to expand their use of ed-tech within their methods and consider digital media like augmented reality, virtual reality, websites, applications, games, social media and video. Their research provided us guidelines and indicators for successful implementation. These include considering ed-tech that

can be successfully integrated, encourages active and engaged learning, is tied to the curriculum, is responsive to the learner's level, is culturally relevant, maintains students motivated, supplements teaching instead of replacing it, involves teachers and parents, represents good value for money and sustainability in time, does not require major changes in infrastructure and does not entail barriers for either gender or for students or teachers with disabilities.

## **Define**

The defining stage consists of synthesizing the user's core problem after analyzing all the information and observations gathered during the user research (The Interaction Design Foundation, n.d.). Directors and teachers saw necessary bolstering the learning process of a wide range of skills. After analyzing the responses and doing secondary research, we decided to focus on emotional awareness and regulation, since these are core skills that need to be addressed and reinforced in the first place to then foster other skills like empathy, assertive communication, and conflict resolution. We concluded that Coschool teachers need a motivating, sustainable and culturally relevant tool to teach emotional awareness and regulation skills to their students because they struggle to apply these skills in their daily life.

## **Ideate**

During this stage designers generate and agree on innovative and alternative ideas to solve the problem, taking into account the insights gathered and challenging assumptions (The Interaction Design Foundation, n.d.). During this phase, we did more research to understand what emotional awareness and regulation entail, the approaches of other programs, and established technological solutions. An ideal tool would favor reflection on emotional states and an understanding of its triggers and physiological signals, augment emotional vocabulary introducing complex and secondary emotions, facilitate the learning of effective regulation

strategies for high arousal and low arousal emotional states, and allow emotional expression to avoid maladaptive behaviors like internalizing, externalizing or suppressing emotions. It would also be tailored to the students' learning level, involve active learning, culturally relevant, motivating, affordable, gender-neutral, accessible, and easy to implement in their context. We also had to choose a solution that we could prototype within our time frame, skill sets, and available resources, and that could be built remotely from our location.

From a content perspective, the aforementioned benefits of games placed them as an optimal solution for emotional learning. A game would apply challenges and active learning methods in comparison to VR experiences or mobile applications that look to promote relaxation and mindfulness meditation in a passive way, taking into account that the students do not enjoy this type of exercise. It would also motivate adolescent students, would allow regular practice without added costs or staff, and could be personalized to fit the student's needs and learning pace, making it a sustainable solution for Coschool. Also, building a simple yet challenging game was within our means. Knowing that music and dance were a popular activity for the students, we researched the use of music for SEL. The methods outlined by Pellitelli et al. (1999, 2005) and Faulkner (2016) that use music as a non-verbal medium for SEL inspired us to create a rhythm game experience that draws on music qualities to provoke emotional reaction in the user and practice emotional awareness, regulation and expression while experiencing them, in a similar way to the biofeedback games previously mentioned.

From a technological perspective, we discarded using biofeedback technology and complex character storylines that would require high-end 3D modeling or animation. VR and AR were appealing options because the organization had already contemplated investing in these technologies and because the devices don't require significant changes in infrastructure. A 6 DoF

VR headset like the Oculus Quest that allows embodied hand movements using wireless controllers could help us simulate percussion performance in digital space realistically and augment the affective experience while maintaining the essence of the learning methodologies. Interactivity through embodied body movements tied to visual and audio feedback while engaging in rhythm gameplay could help us build an augmented learning experience to explain the nature of emotional experiences and reactions. The high level of immersion and sense of presence afforded by VR, the fact that allows an isolated experience, and its effectiveness in generating intense emotions could be definitive factors in getting the student's permanent attention and promote the reflection and introspection needed for emotional awareness. All these factors would converge to create an enhanced immersive experience in a different fashion to other applications.

## **Prototype**

The prototyping phase is an experimental phase meant to start creating inexpensive, scaled-down versions of the solution proposed, or some of its features, to evaluate its effectiveness (The Interaction Design Foundation, n.d.). As a first prototype, we did a storyboard to explain how the experience would work. In this first version, the player is immersed in a peaceful natural environment in VR. In front of the player there is a marimba, a type of xylophone used in Colombian music. Like in rhythm games, the user plays a song following a rhythm that oscillates in tempo. While playing, the surrounding changes according to the level of arousal. For example, if the song played denotes sadness, the environment would turn dark and it will start raining. Using photoshop and images found online, we recreated a 3D model of a marimba in a bright mountain with clear-skies (see Appendix A, Figure A-1) and in a rainy and sad one as well (see Appendix A, Figure A-2). We created a slide deck using these images and



inserted marimba sounds depicting the emotions to explain the basic idea. We showed this presentation to both directors and educators at Coschool in online group sessions.

Educators and directors found the idea appealing and relevant. From their feedback, we learned it is essential to let the player choose the emotions they want to play and engage in so they can have a personalized experience. Educators said it was important to include not only unpleasant emotions but also pleasant ones like joy. Some of them even said we should consider adding a feature that would allow students to augment their emotional vocabulary and showed us a chart they usually use for this. This chart classifies emotions depending on positive and negative valence and their level of energy, in a similar way to the circumplex model of emotion developed by James Russell (Russell, 1980). Educators also found it important to incorporate deep breathing exercises while playing so the students can practice and interiorize this regulation strategy. Educators noted the 3D environments didn't need to be realistic. They saw value in incorporating graphics that could engage students in an aesthetic experience in an unknown scenario that could broaden their perspectives.

We built a second prototype in Unity taking into account their feedback. We learned the marimba wasn't an ideal instrument since the keys are very close between them and limited player movement. We used a set of drums instead. Although the experience would include several emotions, we picked anger for this demo. A music composer helped us create a music track using drums that depicted escalating anger. The song begins in a slow tempo and low volume and progressively increases its pace and volume. When the rhythm reaches its peak, dissonant noises in the background give a sense of unpleasantness. Then, the drumming pauses and the sound of a deep breath is heard. The drumming tempo slows down and pauses a few more times until the rhythm goes back to a calm state. We used this track in Unity to build a

script that generates a note object for every drum onset in the song that moves toward the drums in front of the player. The players must hit the note in sync with the song. This way the level of difficulty increases with the tempo of the song.

We then built a 3D environment of a forest surrounded by mountains around the player using assets from the Unity store. We draw on elements and behaviors found in nature to depict universal emotions. In this case, we attempted to simulate a wildfire as a metaphor for anger in a simple way. We built a Unity shader scripted to change the colors of the trees, the ground, the rocks and the plants in the environment from a calm, cold tone (see Appendix B, Figure B-1) to a bright warm color every time the player hits the drum (see Appendix B, Figure B-2). If the player hits it more frequently the colors in these elements change more strongly. After a few seconds, the colors go back to its original state. This way, the visuals respond to the arousal level of both the player and the music track. The increased difficulty paired with the visual and the audio feedback intend to generate a heightened emotional state in the user that would simulate anger in real life. Like in the examples, this authentic emotional experience is followed by deep breathing exercises, showing the player how to calm the physiological arousal and regain emotional balance through emotional regulation strategies.

In a third prototype, we improved the UI, included the logo of the game that we named HeartTune, and an initial menu that lets the player pick one basic emotion to play (see Appendix C, Figure C-1). We changed the drum set for a pair of congas we modeled and added visual feedback for every time the player hits the note successfully. This made the interaction more natural (see Appendix C, Figure C-2). We added more elements to make the change of color more visible during the emotional peak (see Appendix C, Figure C-3). Text instructions appear

indicating the user when to take deep breaths and encouraging the player during high-arousal states (see Appendix C, Figure C-4).

Additionally, we included a second part that intends to incorporate music improvisation as a means for emotional expression, appealing to the SEL programs that use music for emotional awareness. At this level the player can choose a primary emotion and improvise in the congas how that emotion feels or sounds, facilitating further reflection and understanding of its qualities. After playing for a while, a text asks the player to think of a word that describes that emotion more specifically. Several names of emotions that derive from that primary emotion appear in the environment surrounding the player, allowing him or her to identify and name the feeling experienced and ultimately augmenting their self-awareness and emotional literacy skills (see Appendix C, Figure C-5). The player can also see emotions derived from other primary emotions if he touches it, so he or she can assess and name that emotion correctly, even if it combines different emotions (see Appendix C, Figure C-6). The emotions shown in this section are based in the Atlas of Emotions by Ekman (2016). We used this emotional classification because it breaks down each of the five primary emotions in a range of emotions that go from least intense to most intense, making it an ideal guide for our experience.

To ensure a successful implementation and integration of this tool to current teaching methods, the experience is intended to be used as an introduction or as reinforcement of these SES during the workshops. We believe the tool does not replace the instructions given by the educators nor the workshops as a whole. Rather, it serves as a tool for the students to grow an interest in these skills, gain further knowledge, and apply them and practice them in a digital simulation until they are fully interiorized. We wanted to generate an engaging, useful and

memorable learning tool that would facilitate the teacher's guidance and further discussions with their peers, ultimately helping them develop these skills.

## **Analysis**

HeartTune is a potential tool for teachers in SEL programs to support the learning process of emotional regulation and awareness in teenage students. Although HeartTune was not tested in users, the last prototype and the positive feedback given by experts in SEL on the ideation stage, demonstrate how music-based SEL methodologies, VR features and gaming elements can come together to create a tool that enhances the current development methods of these skills in teenagers. The aforementioned features of the experience, combined with a proper implementation, facilitate the learning of self-awareness by providing an understanding of emotional triggers and physiological changes, encouraging reflection on the qualities and nature of each emotion, and providing an extended emotional vocabulary to accurately identify and name them accurately. It facilitates self-management by letting the player practice deep breathing and relaxation as emotional regulation strategies during high-arousal states.

A complete version of HeartTune would ideally include other music tracks corresponding to other emotional states and show the labels of all emotions during the free play level. A secondary development stage could also let the user save a recording of their gameplay to be able to share it with peers, or include elements like voice recordings of emotional memories, in order to make it a group experience, and introduce skills like empathy and assertive communication.

In accordance with research and Coschool guidelines, the experience accomplishes to promote active learning in educational settings. It is tied to the SEL curriculum thanks to the input of the educators and further research on successful music-based SEL programs. The experience seeks to motivate and attract the student's attention by using elements close to their culture and interests, like music and gaming. Also, the experience is gender-neutral so both men

and women can relate to it. Further user tests are needed to assess its level of engagement, effectiveness and accessibility.

Furthermore, this research project helped clarify how Coschool can successfully implement this type of technology and ed-tech in general. This VR experience does not require big changes to the current curriculum and teachers can use the tool when they see it beneficial. The experience doesn't need to be played by all students at the same time. Teachers can implement it gradually and follow up on the students' progress, asking them questions individually or in small groups to motivate discussions that relate the experience with real-life situations and assure they can transfer these skills to everyday life. This way students can be equipped with emotional skills to handle emotional experiences to their benefit, react in constructive ways in the midst of an emotional event, and ultimately improve their mental health and wellbeing.

It is important though to train teachers and staff on how to use a VR headset and let them get familiarized with it to ensure its integration. Additionally, it is essential to warn all users that using a VR headset for a long period of time can cause eyestrain, dizziness or headache, nor is suitable for children under 13 years old (Aubrey et al., 2018). It is recommended to ask beforehand written consent from the students' parents for them to use this type of technology.

Furthermore, the use of VR headsets and this bespoke experience represents good value for Coschool, since it can be a sustainable solution in time. This tool doesn't need big investments in infrastructure. The organization doesn't need to incur in further costs after the initial investment in the headsets and the completion of the experience. The headsets can be used in different institutions since it is easy to transport these devices to different locations. Finally, the experience can be reused as many times as needed.

## Appendix A - First prototype



Figure A-1. Image of the marimba in a calm environment.



Figure A-2. Image of the marimba in a sad environment.

## Appendix B - Second prototype



Figure B-1. Scene in a low-arousal state.



Figure B-2. Scene in a high-arousal state.



## Appendix C - Third prototype

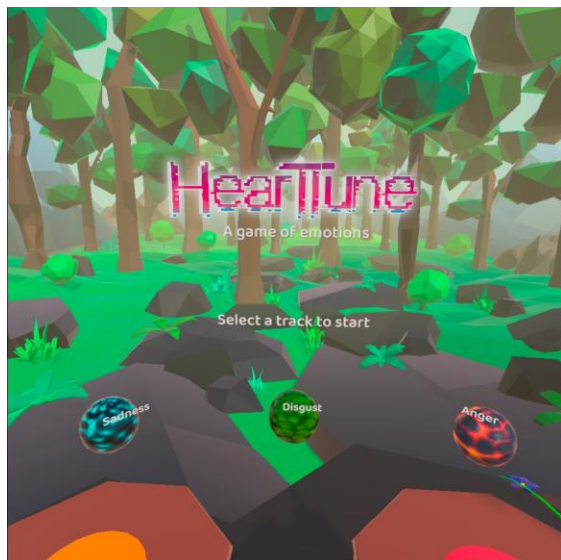


Figure C-1. Menu and UI.



Figure C-2. Visual feedback on congas.

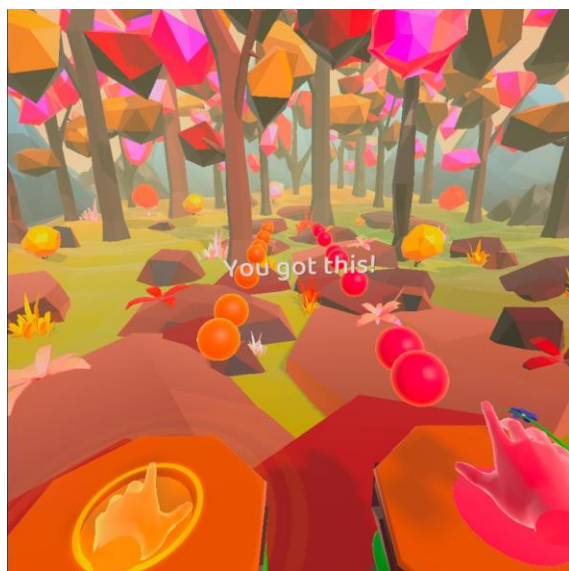


Figure C-3. Scene in a high-arousal state.

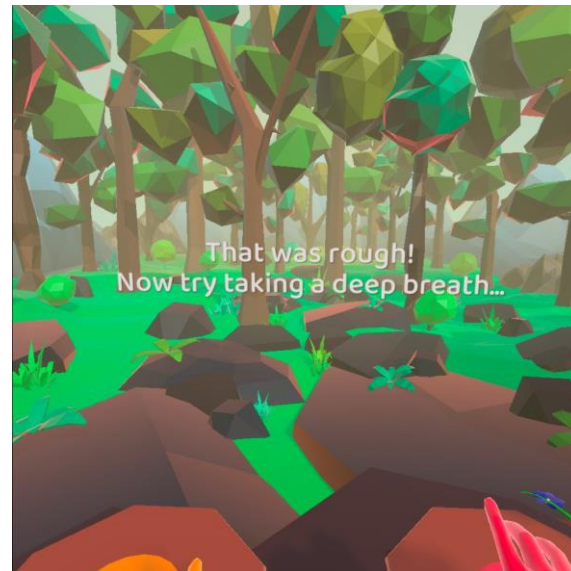


Figure C-4. Text instructions.

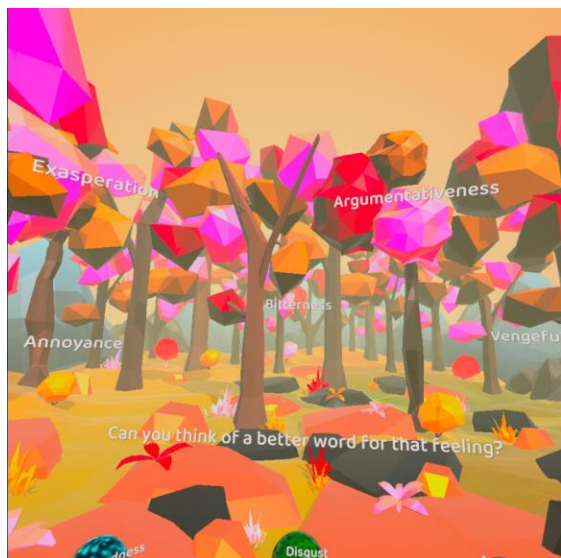


Figure C-5. Emotions derived from anger.



Figure C-6. Emotions derived from sadness.

## Bibliography

- Ai-Lim Lee, E., Wong, K. W., & Fung, C. C. (2010). How Does Desktop Virtual Reality Enhance Learning Outcomes? A Structural Equation Modeling Approach. *Computers & Education*, 55(4), 1424–1442. <https://doi.org/10.1016/j.compedu.2010.06.006>
- Aubrey, J. S., Robb, M. B., Bailey, J., & Bailenson, J. (2018). *Virtual Reality 101: What You Need to Know About Kids and VR*. Common Sense.  
[https://www.common sense media.org/sites/default/files/uploads/pdfs/csm\\_vr101\\_final.pdf](https://www.common sense media.org/sites/default/files/uploads/pdfs/csm_vr101_final.pdf)
- Beck Institute. (2019). *Cognitive Model*. Beck Institute for Cognitive Behavior Therapy.  
<https://beckinstitute.org/cognitive-model/>
- Bossenbroek, R., Wols, A., Weerdmeester, J., Lichtwarck-Aschoff, A., Granic, I., & van Rooij, M. M. J. W. (2020). Efficacy of a Virtual Reality Biofeedback Game (DEEP) to Reduce Anxiety and Disruptive Classroom Behavior: Single-Case Study. *JMIR Mental Health*, 7(3), e16066. <https://doi.org/10.2196/16066>
- Caldas, O. I., Aviles, O. F., & Rodriguez-Guerrero, C. (2020). Effects of Presence and Challenge Variations on Emotional Engagement in Immersive Virtual Environments. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 28(5), 1109–1116.  
<https://doi.org/10.1109/TNSRE.2020.2985308>
- CASEL. (2015). *2015 CASEL Guide: Effective Social and Emotional Learning Programs—Middle and High School Edition*. <https://casel.org/middle-and-high-school-edition-casel-guide/>
- Collett, K., Stoll, N., & Pham, Q. (2016). *Building Resilience Through Emotionally Responsive Gaming: Findings From a Biofeedback Video Game RCT*. BfB Labs. <https://www.bfb->

labs.com/cots

- Cooper, G., Park, H., Nasr, Z., Thong, L. P., & Johnson, R. (2019). Using Virtual Reality in the Classroom: Preservice Teachers' Perceptions of its Use as a Teaching and Learning Tool. *Educational Media International*, 56(1), 1–13.  
<https://doi.org/10.1080/09523987.2019.1583461>
- Dingle, G. A., Hodges, J., & Kunde, A. (2016). Tuned In Emotion Regulation Program Using Music Listening: Effectiveness for Adolescents in Educational Settings. *Frontiers in Psychology*, 7. <https://doi.org/10.3389/fpsyg.2016.00859>
- Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The Impact of Enhancing Students' Social and Emotional Learning: A Meta-Analysis of School-Based Universal Interventions. *Child Development*, 82(1), 405–432.  
<https://doi.org/10.1111/j.1467-8624.2010.01564.x>
- Egan, D., Brennan, S., Barrett, J., Qiao, Y., Timmerer, C., & Murray, N. (2016). An evaluation of Heart Rate and ElectroDermal Activity as an objective QoE evaluation method for immersive virtual reality environments. *2016 Eighth International Conference on Quality of Multimedia Experience (QoMEX)*, 1–6. <https://doi.org/10.1109/QoMEX.2016.7498964>
- Ekman, P. (2007). *Emotions Revealed: Recognizing Faces and Feelings to Improve Communication and Emotional Life* (2nd ed.). Henry Holt.
- Ekman, P., & Ekman, E. (2016). *The Ekmans' Atlas of Emotion*. The Ekmans' Atlas of Emotions. <http://atlasofemotions.org/>
- Faulkner, S. (2016). *Rhythm to Recovery: A Practical Guide to Using Rhythmic Music, Voice and Movement for Social and Emotional Development*. Jessica Kingsley Publishers. <https://ebookcentral-proquest-com.ezproxy.lib.ryerson.ca>

- Faulkner, S., Wood, L., Ivery, P., & Donovan, R. (2012). It Is Not Just Music and Rhythm. . . Evaluation of a Drumming-Based Intervention to Improve the Social Wellbeing of Alienated Youth. *Children Australia*, 37(1), 31–39. <https://doi.org/10.1017/cha.2012.5>
- Friedli, D. L. (2009). Mental Health, Resilience and Inequalities. *World Health Organization*, 64.
- Goleman, D. (2006). *Emotional Intelligence*. Bantam Books.
- Gross, J. J. (2013). Emotion Regulation: Conceptual and Empirical Foundations. In *Handbook of Emotion Regulation*. (2nd Edition.). Guilford Publications. <https://ebookcentral-proquest-com.ezproxy.lib.ryerson.ca>
- Hadley, W., Houck, C., Brown, L. K., Spitalnick, J. S., Ferrer, M., & Barker, D. (2019). Moving Beyond Role-Play: Evaluating the Use of Virtual Reality to Teach Emotion Regulation for the Prevention of Adolescent Risk Behavior Within a Randomized Pilot Trial. *Journal of Pediatric Psychology*, 44(4), 425–435. <https://doi.org/10.1093/jpepsy/jsy092>
- Hromek, R., & Roffey, S. (2009). Promoting Social and Emotional Learning with Games: “It’s Fun and We Learn Things.” *Simulation & Gaming*, 40(5), 626–644. <https://doi.org/10.1177/1046878109333793>
- IDEO (Ed.). (2015). *The field guide to human-centered design: Design kit* (1st. ed). IDEO.
- Ip, H. H. S., Wong, S. W. L., Chan, D. F. Y., Byrne, J., Li, C., Yuan, V. S. N., Lau, K. S. Y., & Wong, J. Y. W. (2018). Enhance Emotional and Social Adaptation Skills for Children with Autism Spectrum Disorder: A Virtual Reality Enabled Approach. *Computers & Education*, 117, 1–15. <https://doi.org/10.1016/j.compedu.2017.09.010>
- Lobel, A., Gotsis, M., Reynolds, E., Annetta, M., Engels, R. C. M. E., & Granic, I. (2016). Designing and Utilizing Biofeedback Games for Emotion Regulation: The Case of Nevermind. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human*

- Factors in Computing Systems*, 1945–1951. <https://doi.org/10.1145/2851581.2892521>
- Ma, M., Oikonomou, A., & Jain, L. C. (Eds.). (2011). *Serious Games and Edutainment Applications*. Springer London. <https://doi.org/10.1007/978-1-4471-2161-9>
- Mikropoulos, T. A., & Natsis, A. (2011). Educational Virtual Environments: A Ten-year Review of Empirical Research (1999–2009). *Computers & Education*, 56(3), 769–780. <https://doi.org/10.1016/j.compedu.2010.10.020>
- Osorio Mejía, A. M., & Aguado Quintero, L. F. (2018). *El Estado de la Niñez en Cali: Una Mirada por Comunas*. Pontificia Universidad Javeriana Cali. <http://www.digitaliapublishing.com/a/55099/>
- Pellitteri, J. (2005). The Use of Music to Facilitate Emotional Learning. In J. Pellitteri, R. Stern, C. Shelton, & B. Muller-Ackerman (Eds.), *Emotionally Intelligent School Counseling* (pp. 185–199). Taylor & Francis Group. <https://ebookcentral-proquest-com.ezproxy.lib.ryerson.ca/lib/ryerson/detail.action?docID=261420>.
- Pellitteri, J., Stern, R., & Nakhutina, L. (1999). Music: The Sound of Emotional Intelligence. *Voices From the Middle*, 7(1), 25–29.
- Pizzoli, S. F. M., Mazzocco, K., Triberti, S., Monzani, D., Alcañiz Raya, M. L., & Pravettoni, G. (2019). User-Centered Virtual Reality for Promoting Relaxation: An Innovative Approach. *Frontiers in Psychology*, 10, 479. <https://doi.org/10.3389/fpsyg.2019.00479>
- Riediger, M., & Klipker, K. (2013). Emotion Regulation in Adolescence. In J. J. Gross (Ed.), *Handbook of Emotion Regulation*. (2nd Edition., pp. 187–202). Guilford Publications.
- Riva, G., Mantovani, F., Capideville, C. S., Preziosa, A., Morganti, F., Villani, D., Gaggioli, A., Botella, C., & Alcañiz, M. (2007). Affective Interactions Using Virtual Reality: The Link between Presence and Emotions. *CyberPsychology & Behavior*, 10(1), 45–56.

<https://doi.org/10.1089/cpb.2006.9993>

Rodriguez, A., Rey, B., Vara, M. D., Wrzesien, M., Alcaniz, M., Banos, R. M., & Perez-Lopez, D. (2015). A VR-Based Serious Game for Studying Emotional Regulation in Adolescents. *IEEE Computer Graphics and Applications*, 35(1), 65–73.

<https://doi.org/10.1109/MCG.2015.8>

Russell, J. A. (1980). A Circumplex Model of Affect. *Journal of Personality and Social Psychology*, 39(6), 1161–1178. <https://doi.org/10.1037/h0077714>

Salzman, M. C., Dede, C., Loftin, R. B., & Chen, J. (1999). A Model for Understanding How Virtual Reality Aids Complex Conceptual Learning. *Presence: Teleoperators and Virtual Environments*, 8(3), 293–316. <https://doi.org/10.1162/105474699566242>

Save the Children. (2017). *Infancias Robadas. Informe Mundial Sobre la Infancia 2017*.

[https://www.savethechildren.es/sites/default/files/imce/\\_stolen\\_childhoods\\_esp-vweb.pdf](https://www.savethechildren.es/sites/default/files/imce/_stolen_childhoods_esp-vweb.pdf)

Scholten, H., Malmberg, M., Lobel, A., Engels, R. C. M. E., & Granic, I. (2016). A Randomized Controlled Trial to Test the Effectiveness of an Immersive 3D Video Game for Anxiety Prevention Among Adolescents. *PLOS ONE*, 11(1), e0147763.

<https://doi.org/10.1371/journal.pone.0147763>

Schoneveld, E. A., Malmberg, M., Lichtwarck-Aschoff, A., Verheijen, G. P., Engels, R. C. M. E., & Granic, I. (2016). A Neurofeedback Video Game (MindLight) to Prevent Anxiety in Children: A Randomized Controlled Trial. *Computers in Human Behavior*, 63, 321–333. <https://doi.org/10.1016/j.chb.2016.05.005>

Schweinhart, L. J. (2003). *Benefits, Costs, and Explanation of the High/Scope Perry Preschool Program*. 11.

Slovák, P., & Fitzpatrick, G. (2015). Teaching and Developing Social and Emotional Skills with

- Technology. *ACM Transactions on Computer-Human Interaction*, 22(4), 1–34.  
<https://doi.org/10.1145/2744195>
- The Interaction Design Foundation. (n.d.). *Design Thinking*. The Interaction Design Foundation.  
 Retrieved August 13, 2020, from <https://www.interaction-design.org/literature/topics/design-thinking>
- TRIPP: Fitness For Your Inner Self*. (2020). Tripp. <https://www.tripp.com/>
- Vaudreuil, C., Chasser, Y., Hoover, C., Jacobs, L., & Hirshfeld-Becker, D. R. (2017). 5.1  
 RAGE-Control: Teaching Emotional Self-Regulation Through Videogame Play. *Journal of the American Academy of Child & Adolescent Psychiatry*, 56(10), S253.  
<https://doi.org/10.1016/j.jaac.2017.09.284>
- Villani, D., Carissoli, C., Triberti, S., Marchetti, A., Gilli, G., & Riva, G. (2018). Videogames for  
 Emotion Regulation: A Systematic Review. *Games for Health Journal*, 7(2), 85–99.  
<https://doi.org/10.1089/g4h.2017.0108>
- Villani, D., Rotasperi, C., Cipresso, P., Triberti, S., Carissoli, C., & Riva, G. (2017). Assessing  
 the Emotional State of Job Applicants Through a Virtual Reality Simulation: A Psycho-  
 Physiological Study. In K. Giokas, L. Bokor, & F. Hopfgartner (Eds.), *EHealth 360°* (pp.  
 119–126). Springer International Publishing. [https://doi.org/10.1007/978-3-319-49655-9\\_16](https://doi.org/10.1007/978-3-319-49655-9_16)
- Weare, K. (2010). Mental Health and Social and Emotional Learning: Evidence, Principles,  
 Tensions, Balances. *Advances in School Mental Health Promotion*, 3(1), 5–17.  
<https://doi.org/10.1080/1754730X.2010.9715670>
- Weare, K., & Nind, M. (2011). Mental Health Promotion and Problem Prevention in Schools:  
 What Does the Evidence Say? *Health Promotion International*, 26(suppl\_1), i29–i69.



<https://doi.org/10.1093/heapro/dar075>

- WEF. (2016). *New Vision for Education: Fostering Social and Emotional Learning Through Technology*. World Economic Forum. <https://www.weforum.org/reports/new-vision-for-education-fostering-social-and-emotional-learning-through-technology>
- Wood, L., Ivery, P., Donovan, R., & Lambin, E. (2013). “To the beat of a different drum”: Improving the social and mental wellbeing of at-risk young people through drumming. *Journal of Public Mental Health*, 12(2), 70–79. <https://doi.org/10.1108/JPMH-09-2012-0002>
- Yamada-Rice, D., Mushtaq, F., Woodgate, A., Bosmans, D., Douthwaite, A., Harris, W., Holt, R., Kleeman, D., Marsh, J., Milovidov, E., Mon Williams, M., Parry, B., Riddler, A., Robinson, P., Rodrigues, D., Thompson, S., & Whitley, S. (2017). *Children and Virtual Reality: Emerging Possibilities and Challenges*. Dubit Ltd, COST Action DigilitEY, WEARVR, Turner. <http://digilitEY.eu/wp-content/uploads/2015/09/CVR-Final-PDF-reduced-size.pdf>
- Yeager, D. S. (2017). Social-Emotional Learning Programs for Adolescents. *The Future of Children*, 27(1), 31–52.
- Zimmer-Gembeck, M. J., & Skinner, E. A. (2011). Review: The Development of Coping Across Childhood and Adolescence: An Integrative Review and Critique of Research. *International Journal of Behavioral Development*, 35(1), 1–17. <https://doi.org/10.1177/0165025410384923>