

# Application of Virtual Reality Technology in Music Therapy for Immigrant Students: Addressing Trauma and Cultural Integration through Music

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**Abstract.** This work aims to investigate the impact of virtual reality (VR) music therapy on the mental health and cultural integration of immigrant students. It comprehensively assesses the therapy's impact on trauma relief and cultural integration is systematically evaluated. A rating system is employed to compare changes in emotional expression, regulation ability, anxiety reduction, trauma recollection, and cultural adaptation before and after the therapy, thereby validating its efficacy. The findings reveal a notable improvement in emotional expression and regulation, with scores rising from 4.1 to 4.9, and an increase in anxiety levels from 4.4 to 4.7, indicating a significant effect on trauma relief. This suggests a significant effect on trauma relief. Furthermore, in terms of cultural integration, cultural adaptation scores increase from 4.4 to 4.9, while identity recognition improves from 4.2 to 5.0, underscoring the significant potential of VR music therapy to enhance cultural integration. These results offer valuable insights into mental health interventions and cultural integration strategies for immigrant students, highlighting new avenues for future research and practical applications.

**Keywords:** Virtual reality music therapy, Immigrant students, Trauma relief, Cultural integration, Mental health.

## 1. Introduction

As globalization accelerates, international migration has become increasingly prevalent, especially in regard to economic and social upheaval. Many families and individuals, often from diverse nationalities (e.g., refugees from Syria, migrant workers from Mexico), are compelled to leave their home countries and relocate to other nations. These individuals may include first-generation immigrants as well as those with multi-generational backgrounds. However, migration involves more than just physical relocation; it also brings about significant changes in language, culture, and social norms. These shifts create substantial psychological stress and adaptation challenges for immigrants, especially adolescent immigrant students [1]. These students often grapple with cultural conflicts, language barriers, identity crises, and emotional trauma resulting from leaving their homeland and loved ones. In recent years, music therapy has gradually emerged as an important tool to help immigrant students address emotional trauma, reduce psychological stress, and promote cultural integration. However, traditional music therapy approaches face practical limitations, such as difficulties in providing personalized treatment and creating immersive experiences. The advent of Virtual Reality (VR) provides a new perspective and tools for psychological therapy, particularly music therapy [2-4].

Cultural integration referred to the process of adapting to and engaging with the cultural practices and values of a new society while maintaining one's identity. This definition is supported by Berry [5], who discuss the balance between adapting to the new culture and retaining original cultural values is important. It evaluates the dimensions of cultural integration in terms of improvement in cultural adjustment, identity enhancement, increase in social interaction, and improvement in language skills, and feelings of comfort in a new environment [5-6]. Trauma relief is defined as the psychological alleviation of trauma resulting from migration. This will be assessed based on emotional expression, lower states of anxiety, fewer memories of traumas, better sleep quality, and higher self-esteem. van der Kolk [7] has given very valuable insight into the above-mentioned indicators, stating that emotional expression and regulation are foregrounded in the recovery process from trauma.

Previous studies have highlighted the significant role of music therapy in aiding psychological recovery following traumatic events. Vinciguerra and Federico found that music therapy was particularly effective in enhancing emotional expression and regulation, providing a safe environment for patients to release suppressed emotions, thereby accelerating their psychological healing process [8]. Vaudreuil et al. further noted that music therapy not only reduced anxiety and depression but also enhanced patients' self-identity and social skills, improving their overall psychological well-being. This approach is especially beneficial for adolescents, as it leverages their interest in music to boost therapy engagement [9]. Gao and Gao demonstrated that integrating VR technology into exposure therapy effectively treated phobias and post-traumatic stress disorder (PTSD). VR allows patients to confront their fears or traumas in realistic, yet safe, virtual environments [10]. Heyse et al. found that VR showed promise not only in exposure therapy but also in emotional regulation and cognitive-behavioral therapy. Through interactions within VR environments, patients can more effectively learn new coping strategies and apply them in real life [11].

Despite the wealth of research on mental health issues like anxiety, depression, and PTSD, studies specifically addressing the psychological needs of immigrant students remain limited. This work focuses on the distinct challenges faced by immigrant students, including cultural adaptation, identity development, and psychological trauma.

## **2. Trauma and Cultural Integration Issues for Immigrant Students**

### **2.1. Psychological Trauma of Immigrant Students**

The samples in this study involve immigrant adolescents aged between 12 and 18 years of age, a critical developmental stage marked by significant psychological and emotional changes. The characteristic features at this stage include difficulties with identity, peer relationships, and stressors. Such students include first-generation immigrants from countries like Syria, Mexico, and Central America, as well as those who come from multi-generational immigrant families. Immigrant students frequently experience significant psychological trauma during the migration process. These traumas can result from war, violence, poverty, or other forms of oppression that compel them to leave their familiar surroundings and relocate to an unfamiliar country. The upheaval and uncertainty of migration can lead to anxiety, fear, and feelings of isolation in students [9]. Additionally, the pain of separation, uncertainty about the future, language barriers, and social isolation can take a toll on their mental health. This trauma not only disrupts their emotional well-being but may also have lasting effects on their academic performance and social adaptation [10].

### **2.2. Application of Music Therapy in Trauma Treatment**

Music, with its unique ability to resonate with the emotional core, provides an effective avenue for emotional expression and regulation for immigrant students. After experiencing trauma, many students struggle to articulate their pain and fear through words, but music offers a non-verbal outlet for emotional release and psychological relief. Listening to or participating in music activities enables students to safely express their emotions, aiding in the processing of traumatic memories and the restoration of emotional balance. In therapeutic practice, music therapy has been widely used as an intervention to alleviate trauma [11]. Music therapists design personalized musical activities for immigrant students, such as improvisation, music listening, and songwriting, to help them gradually confront and address their inner pain [12].

### **2.3. Enhancing Cultural Integration through VR Music Therapy**

VR technology offers a cutting-edge platform for music therapy by creating immersive virtual environments where students can engage with diverse cultural elements. To effectively design VR experiences that resonate with immigrant students, it is essential to incorporate their cultural backgrounds into the VR development process. This begins with an initial assessment to gather comprehensive background information on each student, including their nationality, ethnic

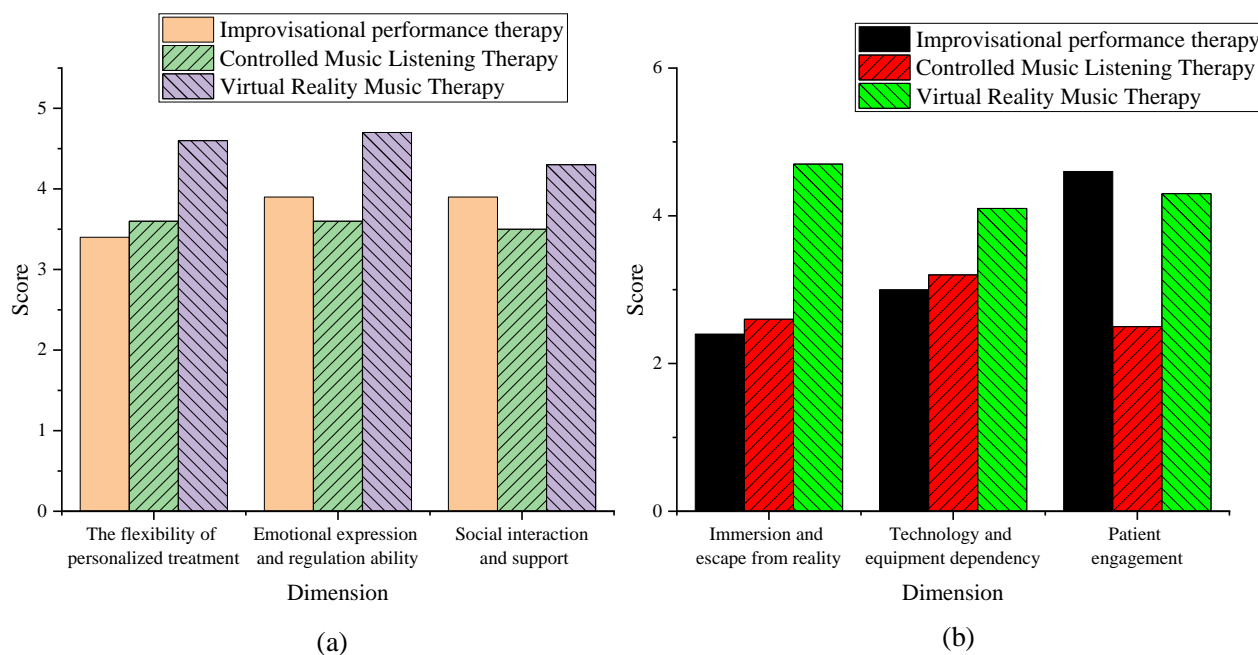
background, cultural symbols, and traditional music preferences. This work evaluates the effectiveness of VR music therapy in trauma relief and cultural integration. Integrating VR with traditional music therapy creates a more holistic therapeutic experience. Therapists can perform an initial assessment traditionally and follow it with customized VR sessions based on the specific needs of the students. This tailored approach allows for ongoing real-time feedback and adjustments, making therapy more responsive to the changing emotional states of immigrant students.

Research demonstrated that culturally tailored VR experiences can significantly enhance a sense of belonging and cultural identity among immigrant students [13]. Such an example of innovation is the fact that therapy done through VR may be adapted to include the immigrant students' cultural background by offering virtual experiences similar to cultural symbols and practices they are used to [14]. Additionally, the design of VR environments must also consider haptic feedback, which plays a critical role in maintaining immersion and enhancing learning, therefore, real-time feedback, a critical component of effective learning, must be adapted to address the varied expectations and learning styles of these students [15]. This immersive cultural experience helps immigrant students gradually adjust to their new cultural context, alleviating the stress associated with cultural conflicts. Exploring and learning about new cultures within a VR environment enables students to better understand and accept the values and behavioral norms of their new environment, thus facilitating their cultural integration. Evidence from VR applications in rehabilitation illustrates the idea that culturally familiar contexts can lead to better treatment outcomes due to increased comfort and engagement [16]. For immigrant students, culturally specific elements should be embedded within the design of the VR systems to maximize their experience and outcomes [17]. Additionally, the safety and controlled nature of the VR environment allows them to explore at their own pace, free from the pressures of real-world society [18]. In VR music therapy, students can engage in music activities tied to their cultural backgrounds, reinforcing their connection to their roots while also being exposed to new cultural music in the virtual space [19]. This combination helps students maintain a sense of identity with their original culture while fostering acceptance and understanding of the new one, promoting a balanced cultural identity.

### **3. Comparative Experiment of VR Music Therapy**

#### **3.1. Comparison between VR and Traditional Music Therapy**

A comparative experiment is conducted to evaluate VR music therapy against traditional music therapy methods, including improvisational therapy and controlled music listening therapy. Statistical analyses, including ANOVA, indicate significant differences ( $p < 0.05$ ) between VR and traditional methods, particularly in emotional expression, engagement, and cultural adaptation. The comparison metrics include patient engagement, flexibility in personalized treatment, emotional expression and regulation, immersion and reality escape, social interaction and support, and dependency on technology and equipment. The evaluation uses a scoring system from 1 to 5, with higher scores indicating better outcomes. Figure 1 presents the experimental results.



**Fig. 1** Comparison between virtual reality and traditional music therapy (a) Active participation (b) Passive participation

Figure 1 shows that regarding patient engagement across different therapy methods, improvisational therapy scores 4.6, indicating high patient engagement. Patients demonstrate strong initiative in improvisational playing, allowing them to freely express and create music. Controlled music listening therapy scores 2.5, reflecting lower engagement since patients mainly passively listen, resulting in relatively low participation. The VR music therapy scores 4.3, indicating high engagement. Patients participate in the therapy through interactive experiences in VR, although they need to adapt to the technical environment. Regarding the flexibility of personalized treatment, improvisational therapy scores 3.4, showing some flexibility in personalized treatment. Patients can choose the music content based on their needs, though this flexibility is limited by their musical skills and expressive abilities. Controlled music listening therapy scores 3.6, offering a degree of personalization through the selection of different music content, but patient engagement remains relatively low. VR music therapy scores 4.6, displaying high flexibility as the VR environment adjusts in real-time according to the patient's needs, providing a tailored treatment experience. In terms of emotional expression and regulation, VR music therapy scores 4.7, excelling in emotional expression and regulation with its combination of multi-sensory experiences and interaction, leading to more significant emotional regulation effects. For immersion and reality escape, improvisational therapy scores 2.4, with immersion depending on the patient's level of engagement in playing, and providing minimal reality escape. Controlled music listening therapy scores 2.6, with limited immersion mainly evoking emotional resonance through music, offering average reality escape. VR music therapy scores 4.7, showing high levels of immersion and reality escape, allowing patients to fully immerse in the virtual world and temporarily escape from real-world stress. In the aspect of social interaction and support, improvisational therapy scores 3.9, with good social interaction, especially in group therapy or interactions with therapists, promoting social skills development. Controlled music listening therapy scores 3.5, with lower social interaction, as it primarily involves the patient's individual experience with music. VR music therapy scores 4.3, enabling the design of social interaction scenarios within the VR environment, enhancing the patient's social support network. Regarding technology and equipment dependency, improvisational therapy scores 3.0, with low technology dependency, mainly relying on traditional instruments and the guidance of therapists. Controlled music listening therapy scores 3.2, with low technology dependency, requiring only playback devices and music resources. VR music therapy scores 4.1, with high technology and equipment dependency, requiring complex VR systems for support.

### 3.2. Effectiveness Analysis of VR Music Therapy

Initial assessments included interviews and surveys, which gave very important information on cultural backgrounds, emotional states, and challenges. With this knowledge, virtual reality environments with relevant cultural symbols and music were created to increase feelings of familiarity and belonging. The design incorporated immersive elements, such as multi-sensory feedback, including haptic sensations that enhanced engagement. Feedback mechanisms in real-time were developed for therapists to constantly be updated about the students' emotional responses, thereby keeping the therapy responsive to changing emotional states. Ongoing evaluations formed part of the design, where regular feedback was sought from students and therapists using the VR sessions for iterative improvements. It is such a systematic approach that can maximize the relevance and effectiveness of therapy, reinforce cultural integration, and hence is holistic for trauma relief.

This work evaluates the effectiveness of VR music therapy in trauma relief and cultural integration. The integration of VR with traditional music therapy could optimize the therapeutic experience through a more holistic approach, virtually and in the real world. For instance, therapists can perform an initial assessment the traditional way and then follow it up with VR sessions according to needs, which will help raise the bar for overall treatment efficacy. This integrative approach also allows real-time feedback and adjustments to make therapy more responsive to changing emotional states for immigrant students. To assess the efficacy of VR music therapy in alleviating trauma, five key indicators are examined. These factors represent the critical facets of trauma recovery identified in clinical practice and a number of theoretical models, including the Polyvagal Theory and Trauma-Informed Care, placing significant emphasis on emotional regulation, processing traumatic memories, and the improvement of physiological states [20].

Table 1 presents the experimental results.

**Table 1.** Assessment of the effectiveness in trauma relief

|                | Emotional expression and regulation ability | Reduction in anxiety levels | Decrease in trauma memories | Improvement in sleep quality | Enhancement of self-esteem |
|----------------|---|-----------------------------|-----------------------------|------------------------------|----------------------------|
| Pre-treatment  | 4.1   | 4.4                         | 4.5                         | 4.3                          | 4.9                        |
| Post-treatment | 4.9   | 4.7                         | 4.7                         | 4.6                          | 4.9                        |

Table 1 shows that the score for emotional expression and regulation ability significantly increases to 4.9 after treatment, indicating that VR music therapy is highly effective in enhancing emotional expression and regulation. The reduction in anxiety levels increases from 4.4 to 4.7, demonstrating a significant decrease in anxiety and an improvement in the patients' psychological state. The decrease in trauma memories rises from 4.5 to 4.7, indicating that the treatment effectively reduces the impact of trauma memories on the patients. The improvement in sleep quality increases from 4.3 to 4.6, showing a positive impact of the treatment on enhancing patients' sleep quality. The score for self-esteem remains stable at 4.9, suggesting that the treatment helps to enhance patients' self-esteem with a consistently stable effect. To comprehensively assess the effectiveness of cultural integration, the experiment selects five indicators: Cultural adaptation reflects the navigation of new social landscapes, and the enhancement of identity addresses issues of belonging. The increase in social interaction helps create bonds that are essentially necessary for the community; an improvement in language proficiency is key to communication. Comfort in the new environment indicates psychological adjustment for successful integration. Table 2 illustrates the experimental results:

**Table 2.** Evaluation of the effectiveness of cultural integration

|                | improvement in cultural adaptation | enhancement of identity | increase in social interaction | improvement in language skills | comfort in the new environment |
|----------------|------------------------------------|-------------------------|--------------------------------|--------------------------------|--------------------------------|
| Pre-treatment  | 4.4                                | 4.2                     | 3.8                            | 3.4                            | 4.2                            |
| Post-treatment | 4.9                                | 5.0                     | 4.8                            | 4.6                            | 4.6                            |

Table 2 shows that the improvement in cultural adaptation increases from 4.4 to 4.9, indicating that VR music therapy significantly helps patients adjust to a new cultural environment. The enhancement of identity increases from 4.2 to 5.0, demonstrating that the treatment significantly boosts patients' cultural identity. The increase in social interaction rises from 3.8 to 4.8, suggesting that the treatment markedly enhances patients' social interactions, contributing to cultural integration. The improvement in language skills increases from 3.4 to 4.6, showing that VR music therapy also has a positive effect on enhancing patients' language abilities. The comfort with the new environment rises from 4.2 to 4.6, indicating that the treatment helps patients adapt to and feel comfortable in their new surroundings.

#### 4. Conclusion

This study evaluates the effectiveness of VR music therapy in reducing trauma and fostering cultural integration for immigrant students. The findings indicated that this method is likely to enhance emotional expression, reduce anxiety, lessen traumatic memories, and further improve sleep conditions while promoting self-esteem. VR music therapy offers a safe platform for emotional release and psychological recovery to address the trauma from migration and promote cultural integration. These findings point out its potential as a proactive intervention that allows students to reconcile their cultural identities and emotional challenges.

Despite the systematic analysis of VR music therapy's effects on trauma relief and cultural integration in immigrant students, there are still some limitations that require further investigation. This work primarily focuses on the short-term effects of VR music therapy, with insufficient evaluation of its long-term impacts. It remains unclear whether VR music therapy can maintain its efficacy in the long term, particularly regarding trauma relief and cultural integration. Therefore, future research should include long-term follow-up studies to assess the enduring effects of VR music therapy.

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