Multimodal Technologies and Interaction

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Systematic Review

Virtual Reality as an Interactive Tool for the Implementation of Mindfulness in University Settings: A Systematic Review

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Abstract: Over the last few years, the importance of Mindfulness in the field of research has grown exponentially, as it has demonstrated various benefits in improving mental health, although there are still various difficulties in putting these techniques into practice among the university population. However, Virtual Reality is emerging as a tool to improve the implementation of these techniques. For this reason, a systematic review was carried out of the different studies that aim to analyze the impact of the use of Virtual Reality for the implementation of Mindfulness techniques that contribute to the improvement of mental health among the university population at national and international levels. For this review, different international reference databases were searched, such as Web of Science and Scopus, and all selected articles had to be published in the period between 2010 and 2024. The selected publications had to be primary research involving a Mindfulness intervention, carried out among university students, and whose main tool for its implementation was Virtual Reality. A total of seventy-eight studies were initially identified, from which fourteen were selected, as the rest did not meet the inclusion criteria. In sum, the results show that the use of Virtual Reality as a tool for the implementation of Mindfulness techniques is certainly effective in reducing and mitigating high levels of anxiety, depression, and stress among university students. All of the research analyzed shows a substantial improvement in the quality of life, mental health, and life satisfaction of the participants.

Keywords: virtual reality; mindfulness; university students; higher education

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1. Introduction

Mindfulness has emerged as a hopeful approach in the search for effective strategies to address the increasing prevalence of anxiety among the university population. Over the last decade, there has been growing interest, not only scientific but also clinical, in understanding and implementing the principles of Mindfulness practice in different settings, including education [1].

Kabat-Zinn (2003) [2] described Mindfulness as intentionally focused awareness of the present moment, as well as the absence of judgement. Mindfulness has gained recognition for its ability to promote psychological and emotional well-being. Its regular practice has shown benefits, such as stress reduction, thus promoting increased emotional resilience and improved cognitive performance, as reported by Hervás et al. (2016) [3]. Nowadays, the university environment is characterized by strict academic demands, social pressures, and high competencies and the development of Mindfulness can be considered an effective solution to counteract anxiety and its manifestations, as Alarcón et al. (2023) [4].

In recent decades, anxiety among university students has maintained its upward trend, which is reflected in academic performance, psychological state, and well-being [5]. Uncertainty about the future both personally, academically, and at work and social expectations foster situations of stress, unease, and anxiety as evidenced by Martínez et al. (2021) [6], this situation highlights the need to implement effective strategies that provide students

with resources and guidelines that allow them to manage their episodes of anxiety and contribute to a better quality of life.

A growing body of scientific literature provides evidence for the efficacy of Mindfulness in reducing anxiety. Several studies show that Mindfulness practice is associated with a significant decrease in anxiety symptoms [7]. Likewise, an improvement in psychological well-being is notable, and implementing this practice as essential to reduce the high levels of stress among university students [8].

In this area, Mindfulness practice emerges as a promising technique for alleviating or reducing anxiety among university students. Despite its multiple benefits, many people report that they find it a difficult task to stay in the present moment, to focus their attention on their own breathing or other Mindfulness exercises [9].

Virtual Reality is an emerging technology that helps to capture people's attention and provides a sense of "being there" in a computer-generated 3D environment, promoting a sense of presence. By limiting distractions, increasing the sense of presence, and providing people with an interesting place to go to practice Mindfulness, Virtual Reality can facilitate Mindfulness practice as demonstrated by Navarro-Haro et al. (2017) [10].

The link between Mindfulness practice and Virtual Reality (VR) has benefits such as less sadness, restlessness, or anxiety and thus more relaxation, and participants show a significant increase in Mindfulness and improvement in emotional state after their Virtual Reality session [3].

In Spain, we can highlight a study published by the Ministries of Universities and Health in which a total of 59,605 university students were sampled (Ministry of Universities and Ministry of Health, 2023) [11] and which shows that one in two participants experienced symptoms of moderate to severe depression and anxiety in the two weeks prior to the study and that nearly one in five students had had suicidal thoughts and suffered from clinical or severe insomnia. Also, 50% of respondents reported having seen a mental health professional, and more than half reported the need for psychological support during the previous academic year.

Mental health problems negatively impact students' development, as they increase school absenteeism rates (Auerbach et al., 2016) [12], and a decrease in school performance is also evident (Bruffaerts et al., 2018) [13]. In this sense, early detection and therefore treatment are essential, which is why the university environment must implement resources that promote psychological well-being (Cuijpers et al., 2019) [14]; therefore, the practice of Mindfulness mediated through Virtual Reality stands as an effective tool to address the present casuistry (Medlicott et al., 2021) [15].

2. Objectives

The main purpose of this review is to compile the most recent (2010–2024) and relevant research, in relation to the concepts: Mindfulness, higher education, and Virtual Reality. To this end, a bibliographic search was carried out in the most important databases (Web of Science and Scopus), and all references that did not involve primary research linked to the aforementioned concepts were discarded.

3. Methodology

Throughout this study, a systematic review was developed as an analysis of primary research was carried out; furthermore, it has a quantitative character and a non-experimental design as the variables already established in the research under analysis are not manipulated.

In order to achieve the satisfactory completion of this process, a series of guidelines and criteria were followed: firstly, the different research questions related to the topic addressed were formulated; then, the search for articles was carried out, adjusting them to the previously established eligibility criteria and facilitating the collection of the data to be analyzed.

To do so, the PRISMA methodology [16] was used, taking into account the articles published in the last fourteen years (2010–2024) and filtering the content according to the existing relationship of the publications.

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology is widely used to improve the transparency and quality of systematic reviews and meta-analysis reports. Some of the key benefits are that it helps to structure the review process in a clear and systematic way, therefore ensuring that the methods are transparent, which is crucial to guarantee the quality and reproducibility of the research, Hutton et al. (2016) [17].

Also, such methodology forces researchers to follow a thorough process to search, select, and include studies. This reduces the risk of overlooking relevant evidence and helps ensure that all available publications are considered. It also promotes the use of predefined criteria for the selection of studies, which helps to reduce inclusion or exclusion biases (Page et al., 2020) [16].

In the same sense, when there are few studies, PRISMA helps to structure how the evidence is synthesized, allowing researchers to systematically describe the findings and limitations of the available literature, which offers a more complete and critical view of the data as detailed by Munn et al. (2018) [18].

By using PRISMA, it makes it easier to identify and document areas where there is a paucity of studies, which provides a solid foundation for future research. This can be useful in justifying the need for further studies in the field or highlighting areas that have not been sufficiently investigated Gough et al. (2017) [19].

Although the number of studies is limited, by following the PRISMA methodology, the review is well structured and documented, which facilitates future updates as more studies are published. This allows the review to be easily expanded when more data become available.

The search terms and Boolean operators used are as follows: (Mindfulness) AND (University students OR Higher Education) AND (Virtual Reality). These terms were combined using Boolean operators (OR and AND) to ensure the retrieval of relevant literature addressing the relationship between Mindfulness-based interventions in higher education implementing Virtual Reality. In the course of the present systematic review, it was observed that most of the available results are published in English; this may be attributed to the fact that this is a novel and growing topic, which is beginning to generate interest and publications within the scientific community. The paucity of research and publications in other languages underlines the need for future research and the potential for significant contributions in this emerging field.

Likewise, a series of inclusion and exclusion criteria were established with the aim of limiting the search to the interests pursued in this research in order to obtain the most relevant articles in this respect. The criteria considered for the selection of articles were as follows:

- Articles published in the period from 2010 to 2024.
- The language of publication is English or Spanish.
- Articles referring to primary research only.
- They are open-access publications, and the full text is available for consultation.
- Articles and applied research by university students applying Virtual Reality for Mindfulness practice.

In contrast, the exclusion criteria used were as follows:

- The publication date is before 2010.
- The language of the publication is a language other than English and/or Spanish.
- The publication does not refer to primary research (systematic reviews, literature reviews, theses, conference proceedings, abstracts, etc.).
- The publication is not open access and/or the full text is not available for consultation.

- The object of study of the research is not university students, or they do not use Virtual Reality for the promotion of Mindfulness, or on the contrary, they use Virtual Reality for a purpose other than Mindfulness practice.

In order to systematize and optimize the review carried out, a virtual software tool called Rayyan was used to carry out systematic reviews, which offers the possibility of storing the bibliographic searches carried out, in order to subsequently select the different articles that meet the inclusion criteria established for the review.

With regard to the data obtained, as can be seen in Figure 1, a total of sixty-eight articles were obtained. Prior to the screening process, none of the records found were eliminated, given that they all met the established date criteria. Therefore, a total of seventy-eight records were retrieved, of which three were eliminated by the review software because they were duplicates; seventeen of the seventy-eight did not include the term Virtual Reality or did not refer to this concept; fifteen did not refer to the concept of Mindfulness either; eighteen of them included as part of their research a systematic, bibliographic, or literature review related to the concept under analysis; also, in ten of them, university or higher education students were not the object of the research carried out; finally, one study was found to not be in open access format. After screening and application of the inclusion and exclusion criteria, a total of fourteen records were obtained for final analysis.

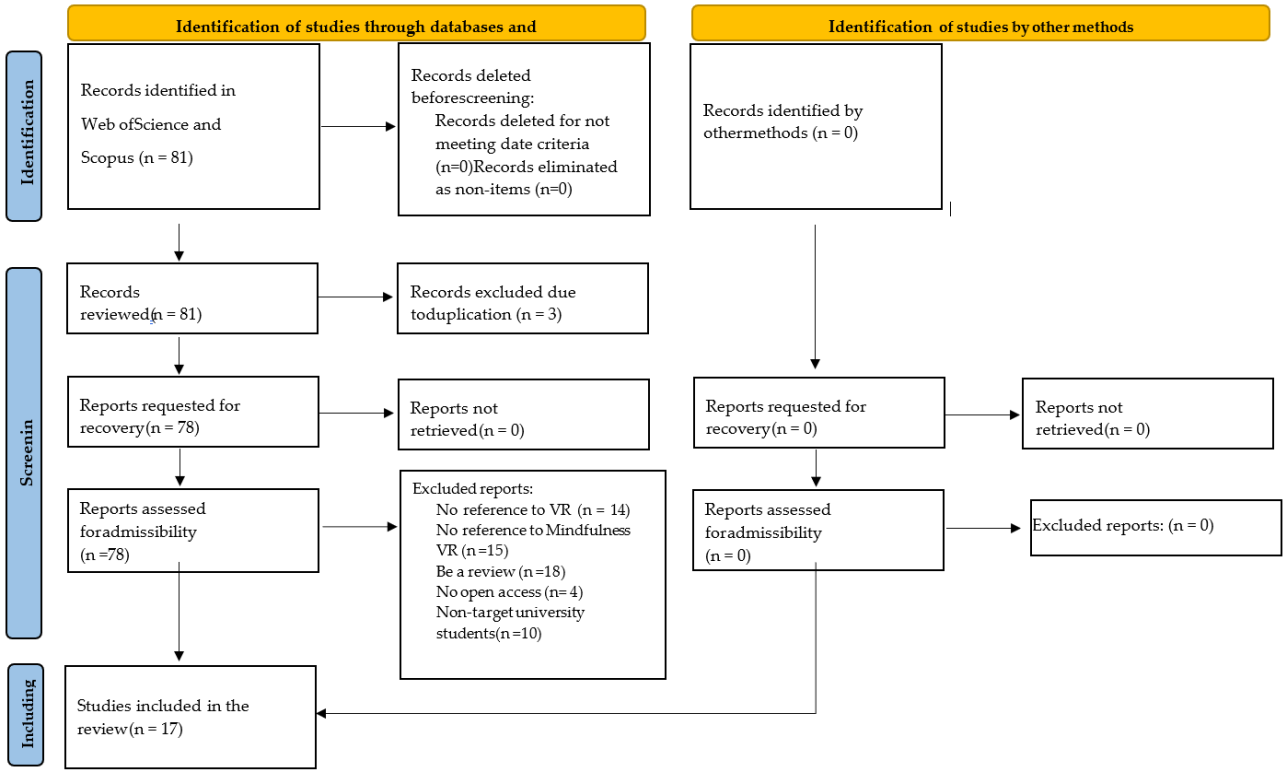

Figure 1. Flow chart of scientific articles for the elaboration of the systematic review according to the PRISMA method [16].

Data from the studies

Table 1 shows the studies analyzed, ordered chronologically by year of publication. In addition, the authorship of the publication, the title of the publication, the sample under study, and the objectives and results of the study carried out are shown in the table.

Table 1. Data from the studies analyzed.

Author/Year of Publication/Title	Sample	Keywords	Objectives	Results
Mira et al., 2016. Access to autobiographical memory as an emotion regulation strategy and its relation to dispositional mindfulness [20].	60 university students.	Mindfulness, Emotional regulation, Autobiographical memory.	To explore the relationship between trait Mindfulness and emotional regulation (ER) through accessing autobiographical memory (AM) as an ER strategy after a sadness induction. To analyze how Mindfulness facets affect the time needed to access personal specific positive memories in response to positive and neutral words. The study uses Virtual Reality as an emotional regulation strategy.	The induction was effective, as evidenced by a significant increase in participants' sadness scores measured by the visual analogue scale (VAS) before and after the induction (from M = 1.69 to M = 4.15). Regarding the results related to VR, the Mindfulness facet called "Non-reactivity" was found to be significantly correlated with the time needed to access specific positive memories in response to positive words after the sadness induction ($r = –0.41$, $p < 0.05$). This suggests that participants with higher levels of "non-reactivity" had faster access to specific positive memories after the VR sadness induction
Crescentini et al., 2016. Psychological and physiological responses to stressful situations in immersive virtual reality: Differences between users who practice mindfulness meditation and controls [21].	41 university students.	Virtual reality, Mindfulness meditation, Anxiety, Physiological measures, Heart rate, Muscle activity.	To investigate the impact of an 8-week Mindfulness-based meditation programme on psychological and physiological responses elicited by immersive virtual environments (IVEs) simulating emergency situations. The study sought to measure whether participants who practiced Mindfulness would show less anxiety and stress, as well as better emotional regulation compared to the control group when faced with stressful situations in virtual environments.	They reported that participants in the MOM group experienced an increase in Mindfulness skills and a significant reduction in anxiety levels (both trait and state). Physiologically, they showed a decreased heart rate and reduced corrugator superciliary muscle activity (associated with negative emotions) during the VR experiences. These changes were not observed in the control group. Furthermore, high-stress virtual environments elicited more anxiety and perceived stress than low-stress environments in both groups, but participants in the MOM group showed a better emotional response overall.
Ahmad et al., 2020. An Eight-Week, Web-Based Mindfulness Virtual Community Intervention for Students' Mental Health: Randomized Controlled Trial [22].	119 university students were divided into three groups: full intervention (F-MVC) with 39 participants, partial intervention (P-MVC) with 35 participants, and the control group with 39 participants.	Mindfulness, CBT, Depression, Anxiety, Students, Universities, Randomized controlled trial, Canada.	To investigate the effectiveness of an online CBT (Cognitive Behavioral Therapy)-based Mindfulness intervention, called MVC, in reducing symptoms of anxiety, depression, and stress in university students.	The main results of the study indicate that the full intervention (F-MVC) and partial intervention (P-MVC) resulted in significant improvements in participants' levels of Mindfulness, anxiety, depression, and stress compared to the control group. Specifically, significant improvements in quality-of-life scales, life satisfaction, and levels of Mindfulness were observed, particularly in the full intervention group.

Table 1. *Cont.*

Author/Year of Publication/Title	Sample	Keywords	Objectives	Results
Miller et al., 2021. Meditating in virtual reality 2: Phenomenology of vividness, egocentricity and absorption-immersion [23].	48 university students.	Virtual reality, Meditation, Positive affect, Presence, Absorption.	To replicate and extend previous findings on the efficacy of Virtual Reality (VR) in facilitating experiences of positive affect and well-being during meditation. To assess whether the phenomenological variables of vividness, egocentricity, and immersion mediate positive affective response. To determine whether individual differences in the trait of absorption predict variability in positive affective response to guided meditation in VR.	Participants experienced greater positive affect in VR-guided meditation compared to non-VR meditation. The increase in positive affect in VR meditation was partially mediated by greater immersion, which was in turn mediated by greater egocentricity. People with greater absorption as a personality trait showed a greater positive response to VR meditation.
Kaplan-Rakowski et al., 2021. The impact of virtual reality meditation on college students' exam performance [24].	61 university students.	Mindfulness, Meditation, Virtual reality, Anxiety, Well-being, Exam.	1. To investigate the impact of meditation, specifically through Virtual Reality, on students' academic performance during exams. 2. To understand how these practices can influence stress reduction and improve concentration and performance in academic tasks.	As for the results, it was observed that meditation had a positive effect on students' performance on computer tests, which consisted of procedural tasks. Pre- and post-meditation tests showed improvements in scores, suggesting that meditation can be an effective tool for improving academic performance and reducing anxiety in exam situations.
Crosswell, 2022. Examining virtual meditation as a stress management strategy on college campuses through longitudinal, quasi-experimental research [25].	5 university students.	Virtual reality, Mindfulness, Stress management, Quasi-experimental research, Longitudinal research.	To evaluate the effectiveness of virtual meditation as a stress management strategy on university campuses. The authors sought to explore whether guided meditation experiences through Virtual Reality (VR) could help reduce stress levels in students, as well as foster cultural acceptance of meditation in the university environment.	It was noted that virtual meditation could be a valuable tool for alleviating stress related to academic workload. However, the authors noted that limitations of the pilot study make it difficult to make conclusive statements about the effects of meditation and suggested that future studies should include larger numbers of participants and more sensitive outcome measures to detect long-term effects.

Table 1. *Cont.*

Author/Year of Publication/Title	Sample	Keywords	Objectives	Results
Whewell et al., 2022. Changemakers as digital makers: Connecting and co-creating [26].	63 university students.	Augmented and Virtual Reality, Twenty-first-century abilities, Cooperative/collaborative learning–cultural projects, Distributed learning environments.	To explore how Virtual Reality (VR) can help university students develop changemaker attributes and identities in educational and business contexts. Investigate the role of technologies in developing students' changemaker identity and cultural competence, using tools such as CoSpaces to create VR experiences that foster international collaboration. To analyze students' engagement with digital technologies used for communication and creation in an international context, highlighting how VR enables students to experience and share cultural environments in innovative ways.	The results of the study indicate that: (1) The use of immersive technologies such as Virtual Reality (VR) has proven to be effective in developing cultural and digital competencies among students. These tools allow students to create and share virtual experiences that foster collaboration and empathy, essential to becoming changemakers in a global context. (2) The experience of working in virtual and collaborative environments promotes a sense of Mindfulness, as students must be present and engaged in the process of creation and co-creation. This approach not only improves their ability to solve problems and make decisions but also helps them develop greater awareness of themselves and others. (3) Students showed a strong drive towards global citizenship and an appreciation of cultural diversity, aligning with Sustainable Development Goals. VR facilitates immersion in different cultural contexts, allowing students to experience and reflect on realities other than their own, thus fostering an open and conscious mindset. (4) The combination of VR and a focus on Mindfulness contributes to increasing students' self-efficacy, as they feel more empowered to face real challenges and contribute to innovative solutions in their communities.
Malighetti et al., 2023. Promoting emotional and psychological well-being during COVID-19 pandemic: A self-help virtual reality intervention for university students [27].	42 university students.	COVID-19, Emotional well-being, Psychological well-being, Self-help intervention, Transformative experience, Virtual Reality.	To explore the feasibility and preliminary efficacy of a self-help Virtual Reality (VR) intervention to promote emotional well-being in college students over a three-week period. The intervention seeks to improve students' emotional and psychological well-being through virtual experiences designed to increase emotional awareness and positive resources.	There was a significant increase in emotional and psychological well-being in the experimental group compared to the waitlist group. Most participants would recommend the experience to other students, suggesting a positive reception of the VR intervention.

Table 1. *Cont.*

Author/Year of Publication/Title	Sample	Keywords	Objectives	Results
Modrego-Alarcón et al., 2023. Effects and Acceptability of virtual reality to facilitate mindfulness practice in university students [28].	93 university students belonging to the University of Zaragoza.	Virtual reality, Mindfulness, University students, State, Mindfulness, Emotional states, Acceptability.	To evaluate the effectiveness and acceptability of Mindfulness interventions through Virtual Reality (VR) environments in university students and to determine which interventions can improve students' emotional well-being and Mindfulness, as well as their satisfaction with the VR experience.	Participants showed significant improvements in Mindfulness and emotional states after VR sessions. They reported a strong sense of presence in the VR environments and high levels of expectation and satisfaction, indicating that Virtual Reality is an effective and acceptable tool for Mindfulness practice in university students.
Sobocinski et al., 2023. Capturing self-regulated learning processes in virtual reality: Causal sequencing of multimodal data [29].	15 university students.	Cognitive load, Heart rate variability, Metacognitive monitoring, Motion, multimodal data, Think-aloud, Virtual Reality.	The main aim of the study was to examine self-regulated learning (SRL) processes in an immersive Virtual Reality environment. Specifically, we sought to: 1. Capture and measure SRL processes using multimodal data, including think-aloud audio, bird's-eye view video recordings, and physiological data. 2. Understand how learners use metacognitive monitoring in response to the cognitive load experienced and how this triggers changes in physical behavior. 3. Explore the temporal and causal relationship between cognitive load, metacognitive monitoring, and behavioral responses during task solving in a VR environment.	The study found that there were no significant differences in participants' cognitive load and movement during metacognitive monitoring compared to when they were not monitoring. However, cognitive load was found to predict metacognitive monitoring at a one-second delay, and metacognitive monitoring predicted changes in movement at all time delays tested. Furthermore, cognitive load also predicted changes in movement at three- and four-second delays. These results suggest that cognitive load acts as a triggering condition for metacognitive monitoring, which in turn causes changes in physical behavior within the VR environment.
Kluge et al., 2023. Evaluation of a Virtual Reality Platform to Train Stress Management Skills for a Defense Workforce: Multisite, Mixed Methods Feasibility Study [30].	189 university students.	Virtual Reality, Workplace Training, Stress Management, Defense.	To assess the feasibility of delivering the stress management training platform, known as Performance Edge (PE), within the existing Australian Defence Force (ADF) group training context. To collect data on critical predictors of user acceptance and adoption of technology in education, including perceived usability, usefulness, and engagement. To assess the impacts of training on stress management.	The Performance Edge (PE) Virtual Reality (VR) platform is claimed to be a viable solution for stress management training as there was an increase in Mindfulness and physical relaxation, as well as a reduction in the rate of breathing.

Table 1. *Cont.*

Author/Year of Publication/Title	Sample	Keywords	Objectives	Results
Poetar et al., 2023. Immersive virtual reality or computerised mindfulness meditation for improving mood? Preliminary efficacy from a pilot randomised trial [31].	47 university students.	Computer, Mindfulness meditation, Mood, Simulator sickness, Virtual Reality.	The objectives of the study were: 1. To compare the effectiveness of VR-based meditation with computerized meditation on mood improvement 2. To assess the presence of simulator illness symptoms in participants who used the VR intervention. 3. To investigate the subjective experience of participants during the interventions.	Significant improvements in the participants' mood were found in both meditation conditions. The VR intervention was shown to be effective, although mention was made of the need to assess simulator illness symptomatology, which could affect participants' experience.
Cawley & Tejeiro (2024) Brief Virtual Reality Mindfulness is More Effective than Audio Mindfulness and Colouring in Reducing Stress in University Students [32].	64 university students.	Mindfulness, Virtual Reality, Stress, Psychological Well-being, Mental Health.	To measure and compare heart rate, psychological well-being, and perceived stress before and after a short session (10 min) of three different interventions (Mindfulness in VR, Mindfulness in audio, and coloring).	Indicated that Mindfulness interventions in both Virtual Reality (VR) and audio and coloring were effective in reducing heart rate, improving psychological well-being, and reducing perceived stress in university students. The VR intervention was found to be the most effective, showing greater reductions in heart rate and perceived stress, as well as significant improvements in psychological well-being, quality of life, life satisfaction, and levels of Mindfulness.
Lillo-Navarro et al., 2024. Effects of a mindfulness-based program on the occupational balance and mental health of university students. Protocol for a randomized controlled trial [33].	210 university students.	-	To examine the differential effects of a Mindfulness-based health care programme (MBHC) without and with Virtual Reality-assisted meditation (MBHC-VR) on occupational balance and mental health in university students.	They show that the implementation of a Mindfulness programme, with and without the assistance of Virtual Reality, had a significant positive impact on the occupational balance and mental health of university students. Participants who received the Mindfulness intervention with Virtual Reality (MBHC-VR) experienced more pronounced improvements compared to those who only received the standard Mindfulness programme (MBHC). These improvements included better emotional regulation, higher levels of Mindfulness, and significantly reduced levels of stress, anxiety, and depression.
Bridge, et al., 2024. A virtual reality environment for supporting mental wellbeing of students on remote clinical placement: A multi-methods evaluation [34].	32 students in the (VR) group. Of these, 11 also completed surveys for the conventional control group.	Mental well-being, Undergraduates, Virtual reality support.	To evaluate a 3D immersive Virtual Reality environment that supports the mental well-being of health professions students in remote clinical placements. To investigate the impact of this environment on reducing anxiety and depression, as well as promoting meditation and support among parents and guardians.	Participants using the VR environment showed improvements in their levels of anxiety and depression, although these improvements were not statistically significant due to the low response rate of the control group. The students appreciated the opportunity to "escape" from their immediate environment and enjoy a relaxing virtual space, which helped them to reduce stress and anxiety.

Table 1. *Cont.*

Author/Year of Publication/Title	Sample	Keywords	Objectives	Results
Hidding, et al., 2024. A single-session VR intervention addressing self-compassion and self-criticism with and without perspective change: Results of a randomized controlled experiment [35].	68 undergraduate psychology students at the University of Groningen.	Cognitive behavioral therapy, Perspective change, Self-compassion, Self-criticism, Virtual reality.	To investigate the effects of a Virtual Reality (VR) intervention on self-criticism and self-compassion: The authors assessed how a VR session can improve self-compassion and reduce self-criticism in university students with high levels of self-criticism. Explore the added value of perspective shifting: The authors examined whether perspective shifting (seeing the situation from another person's point of view) has an additional effect on improving self-compassion and reducing self-criticism.	Reduction in self-criticism: Both groups, with and without perspective change, showed a significant reduction in self-criticism after the VR session. Increased self-compassion: A significant increase in self-compassion was also observed in both groups after the intervention. No significant differences between conditions: No significant differences were found between the perspective change group and the control group in terms of self-criticism and self-pity.
Zheng et al., 2024. Effectiveness of mindfulness-based virtual reality training on stress, anxiety, and depression among Chinese university students [36].	60 university students.	Mindfulness, Virtual Reality, University Students, Psychological Wellbeing, Mental Health, Intervention.	To examine how integrating VR technology with Mindfulness practices can help Chinese university students reduce their levels of anxiety, stress, and depression. To assess the impact of relaxing music in a VR environment on students' mental health, specifically in terms of anxiety, stress, and depression. To determine which of the two interventions (Mindfulness VR or Relaxing Music VR) is more effective in alleviating symptoms of anxiety, stress, and depression in university students. To assess whether the benefits of the interventions are maintained over time, specifically at a 12-week follow-up after the intervention. To investigate students' level of satisfaction with the VR experiences and their willingness to participate in future similar interventions. To generate data that can be used to improve Mindfulness VR and Relaxing Music VR interventions, and to develop new interventional strategies that can be implemented in educational and mental health contexts.	Both interventions (Mindfulness VR and Relaxing Music VR) were effective in reducing levels of depression, anxiety, and stress compared to the control group. The Mindfulness VR group showed a greater reduction in levels of depression, anxiety, and stress compared to the Relaxing Music VR group. However, there were no statistically significant differences in levels of depression, anxiety, and stress between the three groups at the 2-and 12-week post-intervention follow-ups. In summary, both Mindfulness-based Virtual Reality and relaxing music are effective psychological interventions for alleviating negative emotions, with the former being more effective.

Table 1. *Cont.*

Author/Year of Publication/Title	Sample	Keywords	Objectives	Results
Olasz et al., 2024. The Effects of Virtual Reality-Based Mindfulness Exercises on the Perception of Time, Psychological and Physiological States of Young People: A Randomized Crossover Trial [37].	50 university students.	Anxiety, Mindfulness, Psychological well-being, Virtual Reality.	The objectives of the study were: 1. To compare the reduction in anxiety, as measured using the State–Trait Anxiety Inventory for Youth (STAI-Y) score, between the VR and tablet conditions 2. 2. To assess parasympathetic dominance, reflected in heart rate (HR), body temperature, and electrodermal activity (EDA), in the VR condition compared to the tablet condition during and after the intervention. 3. To investigate the perception of time, assessing whether individuals immersed in the VR experience perceived the duration of exercise as shorter than its actual duration, compared to the tablet condition.	The results showed that: In the VR condition, there was a greater reduction in anxiety levels compared to the tablet condition. An increase in parasympathetic dominance was observed in the VR condition, reflected in a decrease in heart rate and changes in body temperature and EDA. Students in the VR condition perceived the duration of exercise as shorter than in the tablet condition. These findings suggest that Mindfulness intervention through VR may be more effective in reducing anxiety and improving time perception compared to tablet use.

4. Results

Research into the implementation of techniques or technologies such as Virtual Reality applied to Mindfulness is one of the fields showing the greatest growth in recent years, given that this emerging technology represents a disruptive strategy in the application of this type of technique to achieve Mindfulness; thus, research linked to these concepts will continue to expand in the coming years; however, at present, studies in this field are limited and there is little scientific literature on the subject, as the application of Virtual Reality in the context of mental health and emotional well-being is only just beginning to be explored. This is due to the fact that it is still an innovative topic, and therefore, this implies that many studies have been published in recent years, with growing interest from various academic institutions worldwide.

First, a bibliometric analysis of the studies selected for this review was carried out.

Likewise, in order to show the origin of the studies analyzed and to establish a globalized vision of where this research is being carried out, Figure 2 shows the different countries from which the studies analyzed on the implementation of Virtual Reality in Mindfulness programmes originate. Furthermore, once the clear international dimension of the studies is evident, we should highlight that practically all of them are written in English, given that this is one of the most predominant languages in the current scientific context.

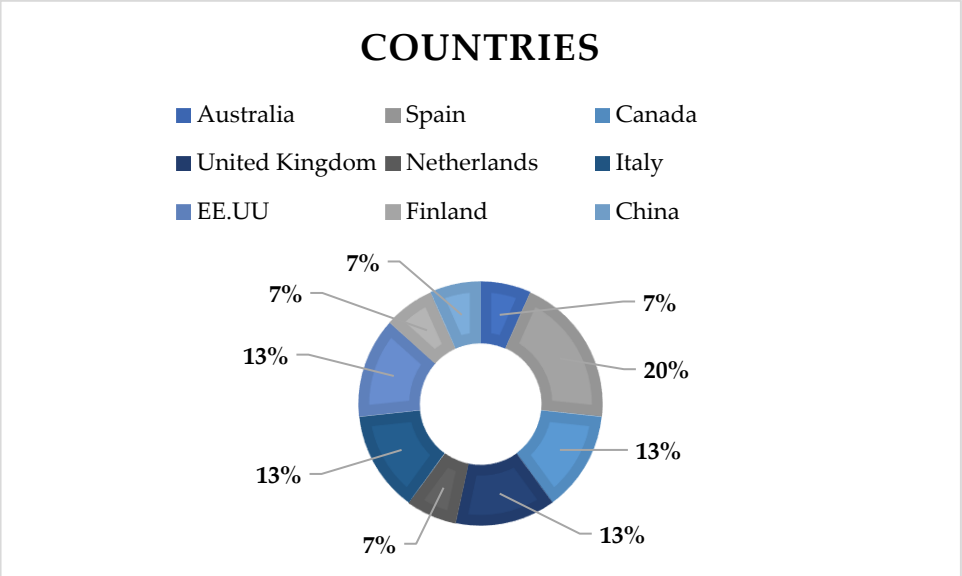

Figure 2. Distribution of the publications analyzed according to country.

Likewise, Figure 3 shows how there has been exponential growth in the number of publications over the years, showing how, among the selected publications, the last few years have seen the greatest number of publications linked to the concepts of the review carried out.

These graphs allow us to visualize both the internationalization of research in this emerging field and the chronology of publications, highlighting recent growth and the potential for future research in this area.

Figure 4 also includes a visual representation in the form of a word cloud, in which the keywords of the research analyzed are highlighted, highlighting the importance of Virtual Reality and Mindfulness. The most relevant terms highlight the most discussed trends and approaches in the field, with special emphasis on the importance of immersive technology as a tool for meditation and anxiety reduction, as well as the growing trend toward personalization and accessibility in Mindfulness practices through Virtual Reality. This visualization complements the findings of the review by visually synthesizing the frequency and relevance of the themes addressed.

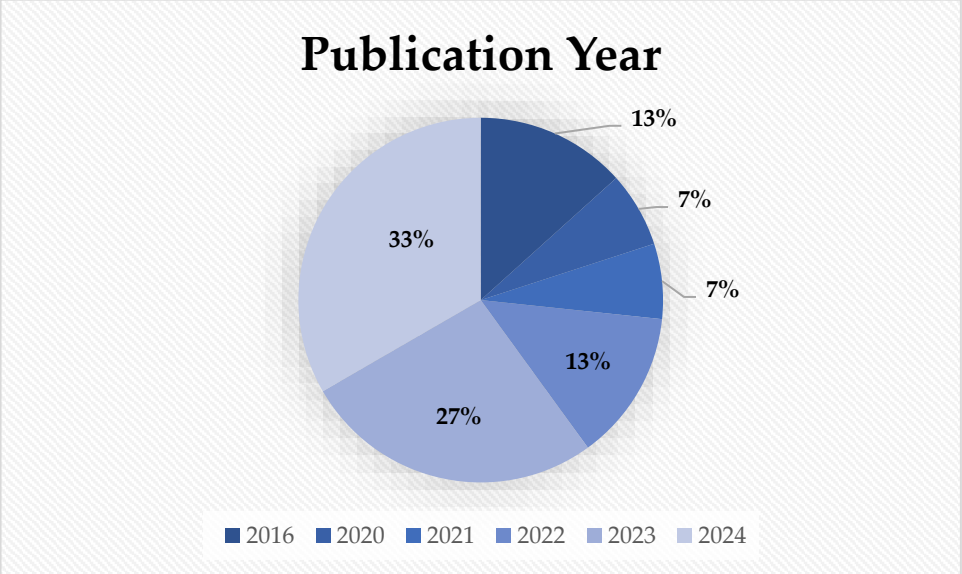

Figure 3. Evolution of scientific publications by year.

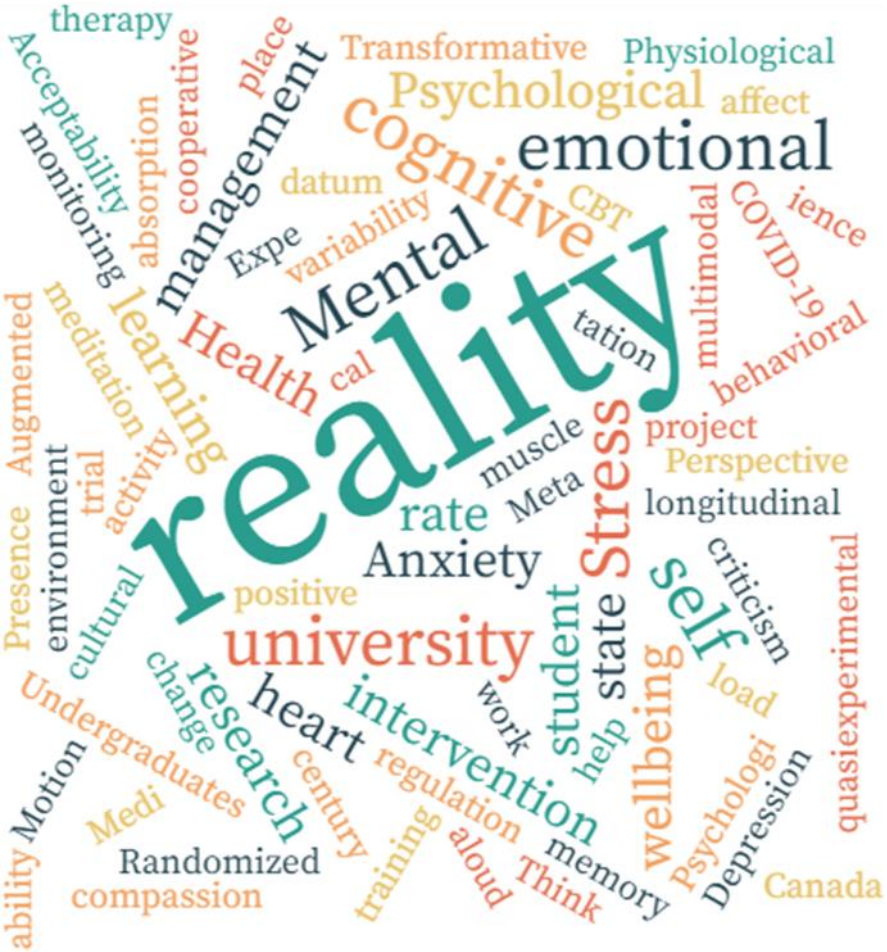

Figure 4. Key concepts of the systematic review.

In order to provide a detailed overview of the different studies selected, some of the most relevant results have been extracted from them:

- Mindfulness favors emotional regulation in a more adaptive way, and those who participate in studies of this type have higher levels of Mindfulness and have faster access to positive memories, which favors a more effective emotional regulation [20].
- Psychological and physiological responses are improved through the implementation of meditation techniques mediated by Virtual Reality; this is evidenced by the observation of lower levels of anxiety in users of such programmes, and it also improves mental health and stress management [21].
- Mindfulness mediated by Virtual Reality favors the improvement of depression and anxiety states, at the same time, it increases the feeling of improvement in the quality of life and satisfaction with it [22].
- The importance of incorporating relaxation techniques, such as meditation through Virtual Reality, in educational environments, especially at times of high pressure, such as before final exams or presentations, is evident [23].
- Meditation in Virtual Reality environments facilitates positive experiences and promotes well-being compared to traditional meditation [24].
- Virtual meditation is a very effective tool because it reduces stress and anxiety levels; it also facilitates a greater number of students to engage in stress management practices; therefore, the implementation of virtual meditation programmes on university campuses can contribute to promoting a culture of positive and proactive mental health [25].
- Mindfulness practice through VR fosters empathy, innovation, and critical thinking or self-efficacy [26].
- The implementation of virtual resources to Mindfulness practice significantly increases emotional well-being [27].
- Virtual Reality stands as a valuable tool in the promotion of mental health and emotional well-being in higher education, offering an innovative alternative to traditional interventions [28].
- By monitoring cognitive processes while students interact with Virtual Reality, an increase in self-regulation skills was observed; this demonstrates that immersive environments can facilitate self-regulation in learning [29].
- The use of Virtual Reality is effective due to increased skill proficiency, improved stress management, and reduced respiration rates [30].
- VR-based meditation shows a reduction in negative emotions, indicating a significant increase in positive mood, and VR increases accessibility which could help reach a wider audience and promote mental health [31].
- Virtual Reality offers additional restorative benefits and triggers positive physiological responses, significantly improving psychological well-being [32].
- Mindfulness programmes early in academic life prevent mental health problems and promote a balanced lifestyle [33].
- Mindfulness practices mediated through Virtual Reality provide an escape from anxiety [34].
- Virtual Reality-supported interventions can be effective in reducing self-criticism and enhancing self-compassion [35].
- The combination of Mindfulness and relaxing music in a virtual environment provided a restorative effect, improving well-being; the integration of innovative technologies, such as Virtual Reality, into mental health programmes may be a promising strategy to address psychological problems [36].
- University students prefer contemporary technological solutions for mental well-being, suggesting that technology-based Mindfulness interventions may be a valuable tool for addressing mental health issues in this population [37].

Finally, in terms of the objective of the different studies analyzed, practically all of them sought to find out whether using Virtual Reality within Mindfulness programs led to an effective reduction in anxiety levels compared to the application of this type of programme without the application or use of this technology. The studies affirm that, if

this type of technology is implemented for the application of Mindfulness programmes among the university population and higher education students, whether it is a total or partial intervention, there is evidence of significant improvements in the acceptance of Mindfulness programmes, as well as in the level of Mindfulness and the reduction in anxiety, depression, and stress levels among the participants in comparison with the control groups established in the different studies. In addition, it is noteworthy that the complete interventions under analysis have shown that the application of Mindfulness programmes mediated by Virtual Reality offers improvements in the quality of life and satisfaction with life among the students under study.

In general terms, we can affirm that all of the primary research studies analyzed offer encouraging results since the application of Mindfulness programmes mediated by Virtual Reality significantly improves the emotional state of the students participating in the studies. Furthermore, the degree of satisfaction of the sample participating in the studies with the use of this type of technology shows that their expectations are fulfilled, as well as having a high degree of satisfaction with the programme carried out.

5. Discussion and Conclusions

The systematic review that has been carried out shows that the number of articles that study the treatment of Mindfulness or Mindfulness mediated through Virtual Reality in university students has been increasing in recent years, due to the fact that it is an essential factor for the integral development of university students. During the present study, a total of 17 research studies were registered, showing an increase in the current interest in this subject, as 60% of the research studies were carried out in the last two years. All of them agree that the main area for improvement is focused on the psychological well-being of the student. As for the studies classified according to the aspects of improvement to which they are directed, it is convenient to discuss the results according to the reduction in stress, emotional regulation, improvement of mental health, decreased presence of anxiety levels, and therefore higher academic performance.

The analysis of the literature reviewed consistently shows that programmes based on Mindfulness significantly promote the development of self-regulation skills, as Modrego-Alarcón, et al., 2023 [28] and 2024 [33] affirm that these programmes, by focusing on practices that train Mindfulness in the present moment, contribute to a greater capacity for emotional management, thought regulation, and impulse control, and as a result of this training in self-regulation, participants' anxiety levels tend to be reduced, which in turn favors an improvement in their general psychological well-being. In accordance with the above, Zheng et al., 2024 [36] explain that the reduction in anxiety is produced by the increase in people's ability to observe their thoughts and emotions without reacting automatically or impulsively, which allows for greater mental clarity and a more adaptive response to stressful situations; by integrating techniques such as meditation, conscious breathing, and non-reactive observation, these programmes provide participants with tools to strengthen emotional resilience and psychological balance [20].

On the other hand, studies such as those by Moses et al. (2016) [38] show that the practice of Mindfulness offers significantly greater mental health benefits compared to those obtained through traditional activities such as diet and physical exercise. Similar data can be found in other studies such as that of Dvorakova et al. (2017) [39] where the effectiveness of a Mindfulness programme in promoting the health and well-being of students is highlighted, as the results show a significant increase in life satisfaction and a decrease in levels of depression and anxiety.

Therefore, during the development of this systematic review, it was observed how the practice of Mindfulness can contribute to the improvement of mental health, helping to cope with and alleviate stress and anxiety to a great extent, which is crucial in the university environment as Olasz et al., 2024 [37] expose in their study; they also show the need to explore the responsiveness to Mindfulness skills training linked to Virtual Reality for people who meditate and have experience compared to less experienced people. However, Kluge

(2023) [30] emphasizes the importance of immersion and a sense of presence in training environments, because Virtual Reality can generate emotional responses and enhance training effectiveness by providing an environment that simulates real situations, which cannot be achieved by other techniques.

Other studies also show a significant increase in Mindfulness after one or several Mindfulness sessions through Virtual Reality; Chandrasiri et al. (2020) [40] highlight the link between Virtual Reality and Mindfulness as a potential tool for the prevention of mental health problems and the promotion of psychological well-being, given that it improves emotional state in the short term and may have a longer-term influence by developing students' skills and strengths to cope with difficulties and regulate their emotions. On the other hand, the implementation of this type of prevention strategy in university students covers a social need that is considered a public health problem due to evidence showing that this population is exposed to various stressors that can negatively affect their psychological well-being [28].

Another of the positive effects of Mindfulness is the improvement in academic performance, as stated by Xu et al. (2016) [41], as they link Mindfulness with an increase in satisfaction in the perception of educational environments and the learning environment, improving academic results. Along the same lines, Hidding et al. (2024) [35] show that it is necessary to create active teaching-learning programmes with Virtual Reality, which must be conceptualized in a pedagogical way to promote the active Teaching-Learning process with Virtual Reality.

In terms of the limitations of the present study, it was identified that the selected sample presents significant restrictions. Although there is an abundant amount of scientific literature related to Mindfulness, by limiting the search to research that analyses Mindfulness practice mediated by Virtual Reality (VR), the availability of sources is considerably reduced. Furthermore, the focus of the study is limited to a specific educational context: the university setting; this sectoral delimitation further reduces the breadth of the sample, as studies related to the use of Virtual Reality in the field of educational Mindfulness, especially at the university level, are scarce. Therefore, the size of the sample and the diversity of the data collected are affected by the specialized and emerging nature of the topic as well as the sectoral focus. This may influence the generalisability of the results and the ability to extrapolate the findings to other educational contexts or wider populations.

With regard to future lines of research, and given that it is currently beginning to be an emerging topic, the search could be extended to other educational environments and thus generalize the results. Furthermore, a study could be conducted to examine the long-term effects of Virtual Reality-mediated Mindfulness on psychological well-being, stress management, and academic performance in university students, as many studies measure short-term impact but do not explore whether the benefits are sustained over time. Furthermore, it would be beneficial to investigate how personalizing Mindfulness sessions through Virtual Reality, adjusted to the psychological and demographic characteristics of students (age, gender, university grade, and stress or anxiety levels), can improve their effectiveness, as the research reviewed has not yet explored in depth how these practices could maximize results in terms of Mindfulness and stress reduction. Similarly, barriers and facilitators to the adoption of Virtual Reality in university Mindfulness programmes, such as technological infrastructure, acceptance by teachers and students, and associated costs, need to be analyzed, as wider implementation in universities is essential to understand what factors may drive or limit the implementation of this technology in curricula and psychological well-being programmes.

By way of conclusion and after the theoretical foundation given, as well as the review and analysis of the different studies taken as a reference, we can affirm that Mindfulness practices mediated by VR stand as a key tool for improving the well-being, mental health, and performance of students in the university environment. The practice of Mindfulness has been linked to a reduction in anxiety levels as well as to the improvement of emotional well-being, but the implementation of emerging technologies such as Virtual Reality for its

practice is in an incipient state that is gradually gaining momentum; although, the potential for improvement offered by the use of Virtual Reality has become evident.

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