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Systematic Review

Mixed Reality in Undergraduate Mental Health Education: A Systematic Review

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Abstract: The landscape of Extended Reality (ER), which includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) is rapidly changing. However, despite the promising results from many randomized controlled trials (RCTs) developed on healthcare environments, there is a lack of standardization, specifically to determine their effectiveness in academic settings. To our best knowledge, this is the first systematic review addressing the efficacy of MR to enhance learning and skills acquisition in undergraduate mental health education. The purposes of this study were to review the scientific literature of those studies involving MR and undergraduate mental health education, to answer the two following questions: (1) Is MR useful to enhance the acquisition of knowledge and skill training in undergraduate mental health education, and (2) Which are the advantages and disadvantages that should be addressed to successfully develop MR in undergraduate mental health education? We conducted a systematic review of the peer-reviewed literature from EBSCO, Ovid, PubMed, and Scopus y WOS (Web of Science), following the PRISMA statements and using "mixed reality + education", "mixed reality + student", "mixed reality + undergraduate", and "mixed reality + mental health", as keywords. Those studies published between 2012 to present, in English or Spanish language, were reviewed. A total of 2608 records were retrieved, and only 6 publications met the inclusion criteria, and were finally included. MR training used was varied. There were no studies providing specific outcomes regarding the student's acquired knowledge (theoretical concepts) after using MR. Several strengths and weaknesses of using MR with students were discussed. The results will be useful to develop innovative MR strategies to improve undergraduate mental health education, due to the lack of studies focused on this topic.

Keywords: mixed reality; education; undergraduates; students; mental health

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1. Introduction

Due to the fast-paced progress of different technological developments, concepts such as Extended reality (XR), which encompasses Virtual reality (VR), Augmented reality (AR), and Mixed reality (MR), have emerged. This technology offers a wide range of application possibilities in the training of medical students, and its use is exponentially growing [1]. Moreover, it is expected to increase in the near future [2].

1.1. Mixed Reality

The term "mixed reality" is not new, due to its introduction in 1994 by Paul Milgram and Fumio Kishino in their work titled "A Taxonomy of mixed reality Visual Displays" [3]. MR constitutes a hybrid technology that merges the functionalities of VR and AR [1]. In MR, virtual objects are projected into the subject's real environment, involving any degree of a combination between AR and VR (e.g., presenting real images within a simulated virtual environment), and is less commonly used when compared to VR or AR [4]. Both the use of VR and MR is changing rapidly, as are the devices that can provide this type of technology [4]. An example of a headset which supports MR would be HoloLens2©. It has been used in domains such as data visualization, entertainment, industrial training, education, and tourism [5]. MR has also been extensively used in healthcare education in areas such as anatomy or anesthesia, showing promising results [6]. Recent studies have mainly focused on evaluating students' acquisition of certain skills, the majority (80%) showing an effective increase in acquired knowledge in health professions [7].

1.2. Advantages of MR Use

Studies that incorporate this type of technology into education have an enormous potential to impact and add value to the learning process of healthcare workers, and therefore, improve the quality provided to patients [7]. MR technologies have the potential to provide students with an effective learning experience by bridging the gap between the digital and physical world [8]. It represents a potential benefit in its application to education in the field of medicine, for practicing complex procedures [9].

MR has also demonstrated the potency to improve scientific understanding and e ducation by transforming passive learning with textbooks and plastic models into engaging interactions with 3D objects [10]. Students can actively learn the content presented in their studies with the help of these devices, which increases spatial understanding and overall engagement with the study material [11]. There are reports of holographic devices, such as Microsoft's HoloLens, being efficient, accurate, and hands-free tools in medical training [12].

Other benefits of using MR with students included: a significant increase in the quality of implementing skills previously trained (compared to traditional teaching models) [6]; effective increase in knowledge acquisition in health professions [7]; enhanced learning experience [13]; high long-term retention of medical skills [14]; improvement in the quality of the teaching and learning process by improving final performance [15]; higher ecological validity [4]; higher self-efficacy [13] and engagement [13,16,17]; high enjoyment through simulation [18]; high end-user satisfaction [6,13]; and a higher sense of "being present" [8,19,20].

That sense of "being present" refers to the feeling of being really "present", within a virtual world, when the user is not actually in it [3]. High levels of "sense of presence" have been positively associated with better performance in trained tasks, as well as a greater experience of enrichment, motivation, and enjoyment of the activity [21–23]. Moreover, greater accessibility of devices that support VR and MR for the general public has become evident, due, on the one hand, to their integration in cell phones and computers commonly used in everyday life; and on the other hand, due to the progressive decline in their economic cost [24].

MR is able to produce an authentic experience of connection between the real physical environment and the virtual world, providing interaction with high realism and an "immersive" experience, while preserving the feeling of being present, which makes this technology a promising tool for use in health education [6]. In fact, several authors have pointed out the convenience of abandoning traditional models of passive training, which could be less effective, in order to incorporate these types of technological tools [25]. They allow for the measurement of several outcomes related to the learning process, such as knowledge acquisition and skills training, while providing feedback on the results obtained [6].

Regarding the students' point of view, many of them reported high satisfaction after using immersive technology [13], highlighting it was a very useful educational tool for clinical training and healthcare [18]; they even requested that this kind of technology should be included in the medical curriculum [26]. When students were asked about the experience of using MR through Microsoft HoloLens in their classroom, they mentioned the interaction, immersion, and feeling of "being present" as some of the main advantages [8], and even the majority of the students stated that MR applications should be employed in all courses and expressed that they are excited about the use of these applications, which increase their motivation. [27].

1.3. Disadvantages of MR Use

Some limitations of using MR technology include the lack of empirically validated treatment protocols, as well as standardized and accessible training, so that those professionals who are interested in using VR or MR can receive adequate training for its correct use [4].

There were common factors identified, almost unanimously and repeatedly, by several studies focusing on the application of MR in the clinical and educational setting, as areas of improvement: (a) the need to standardize virtual protocols [6,7]; in order to be able to replicate and compare the results obtained [2,4]; (b) establishing clear and concise objectives, in relation to the application of VR and MR in the healthcare teaching environment, which would allow the benefits they bring to learning to be clearly identified [6]; (c) the invalidity of the conclusions drawn, largely due to the heterogeneity of the research designs and the variety in the presentation of the results obtained [6]; (d) the lack of clarity and robustness in their experimental designs [7]; (e) the lack of controlled clinical trials, as recommended experimental designs, that enable verification of the effectiveness of the use of MR [1,4,7]; and specifically the need for RCTs to determine the effectiveness of applying digital tools to the health education setting [7,28,29]; (f) the heterogeneity of participants and interventions employed [7]; (g) the scarcity of standardized measurement instruments with empirical validity [7]; (h) the need to further assess relevant variables such as students' attitudes and satisfaction with the use of this technology [1]; (i) the need for further study of the mechanisms involved in the feeling of "being present" or the "immersive" experience, due to its relevance as a possible determinant of therapeutic success; and finally, (j) the recommendation that prototype applications incorporating VR should be designed through the conjunction of interdisciplinary professions, providing theoretical knowledge (from the academic environment), practical knowledge (from the industry), and guidelines on their appropriate implementation by the healthcare professionals involved [30].

In educational environments, information overload and unfamiliarity with virtual elements have been pointed out as causes of students' cognitive overload and acute stress [17]. In a similar way, educational effects are limited to narrow age groups, subjects, and the effectiveness constructs that measure learning outcomes are still scattered [31]. As such, there is a clear lack of standardized protocols for applying MR to education [6], and clearly in medical education [7]. Therefore, the aim of this study is to review the scientific literature of those studies involving MR and undergraduate mental health education, published in the last decade, to answer the following two questions: (1) Is MR useful for enhancing knowledge acquisition and skill training in undergraduate mental health education?; and (2) which advantages and disadvantages should be addressed in order to successfully deploy MR for undergraduate mental health education?

2. Materials and Methods

2.1. General Description

A systematic search strategy was implemented in November 2022 to find all the relevant studies involving the use of MR in undergraduate mental health education. It was performed and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (see study protocol in Multimedia File S1) [32]. The protocol was registered with the PROSPERO International Prospective Register of Systematic Reviews (CRD42022379339).

2.2. Selection Criteria

Inclusion criteria: The study papers were considered relevant if they were journal articles involving MR to enhance the acquisition of knowledge and/or skill training in undergraduate mental health education. Those studies involving mental health-related skills trained through MR strategies were also included, even if this training was provided to non-mental health undergraduate students (but healthcare ones, as nursing or medical students). Studies should be published in English or Spanish language, along the last decade (between 2012–November 2022), providing specific outcomes (quantitative results).

Exclusion criteria: Studies involving the use of MR with non-mental health undergraduate students were excluded unless the MR based training was focused on a mental health related skill (i.e., counselling skills, self-efficacy, or motivation). Furthermore, those manuscripts in which MR was used to train a non-mental health-related skills (i.e., engineering, electronic, computing skills), as well as those involving healthcare students (i.e., medical, nursing or paramedic students) trained in non-mental health-related skills (i.e., how to manage clinical variables in emergency cardiology cases; or to better develop a cadaveric dissection; or to better undergo with a catheterization; or how to improve technical or clinical reasoning skills; or basic life support-BLS- skills) were discarded. Protocols with unpublished results, narratives reviews, no journal articles (conference proceeding, book chapters or theses), or published in a language other than English or Spanish were also excluded. Conference manuscripts were discarded as their inherent extensions do not provide enough information to properly analyze the primary and secondary outcomes outlined in the present study.

2.3. Outcomes

The primary outcomes were the mental health-related variable targeted, the type of MR training provided, and its usefulness to enhance the knowledge acquisition and skill training in undergraduate students. The secondary outcomes were the main advantages and disadvantages of the trainings developed, as well as the students' satisfaction levels after using MR.

2.4. Search Methodology

A comprehensive search was carried out in EBSCO (Academic Search Complete, CINAHL Plus with Full Text, Communication Source, eBook Collection, E-Journals, ERIC, Fuente Academica Premier, Humanities International Complete, MEDLINE, MLA Directory of Periodicals, MLA International Bibliography, OpenDissertations, PSICODOC, Psychology and Behavioral Sciences Collection, PsycInfo), Ovid, PubMed, Scopus y WOS (Web of Science Core Collection), from inception until November 2022. The detailed search strategies used in all databases are provided in the Multimedia File S1. All original research articles were retrieved for examination, and a search library was created using RefWorks©, a bibliography management program.

2.5. Data Collection and Analysis

Two authors (IR and PA) independently evaluated and reviewed for completeness all titles and abstracts following 3 phases: first, the titles of the records were assessed; then their abstracts; finally, if after reading the titles and the abstracts, a reviewer considered that a reference was relevant, the full text of the paper was extracted. After this, Cohen kappa scores were calculated to measure the inter-rater agreement between the 2 investigators (IR and PA). The interpretation of the Cohen kappa coefficient was calculated using SPSS version 27 (IBM Corp) and was based on the categories developed by Douglas Altman [33]: 0.00–0.20 (poor), 0.21–0.40 (fair), 0.41–0.60 (moderate), 0.61–0.80 (good), and 0.81–1.00 (very good). In case of discrepancies, a third author was consulted (CM). Cross-checking was carried out to identify any inaccuracies or oversights (ER). Any other discrepancies were resolved amongst the core team with the involvement of the broader research team when necessary.

2.6. Data Extraction and Management

We extracted data based on (1) publication year, (2) country, (3) study design, (4) study aim, (5) sample size and mean participants' age, (6) college degree, (7) targeted mental health related variables, (8) training using MR, (9) useful to acquire knowledge-theoretical concepts, (10) useful as a training in new skills-practical concepts, (11) main advantages/disadvantages, and (12) students' satisfaction.

2.7. Quality of Studies Included

Given the variety of the research designs, the quality of included studies were appraised using the Mixed Methods Appraisal Tool (MMAT) developed in 2006 [34] and revised in 2018 [35]. The overall scores with the highest values indicated a lower quality of included studies (see Multimedia File S2). One author (CM) independently extracted data on outcomes from all studies. Data were reviewed for completeness by one reviewer (ER).

2.8. Statistical Analysis

Data were pooled using the program SPSS v. 27 (IBM Corp), which allowed an analysis of frequencies (percentages), as well as means.

3. Results

3.1. Study Selection and Inclusion

A total of 2608 records were included in RefWorks©, through the electronic database search. After removing 1448 duplicates, another 693 studies were discarded for not complying with the inclusion criteria (no journal papers). Then, 467 records were evaluated based on the title and abstract. Of those, 437 were removed because they clearly did not meet the inclusion criteria. Therefore 30 papers were selected for a full text reading; 24 out of these [36–59] being discarded for various reasons (see Multimedia File S3). A total of six publications were finally included [60–65]. The Cohen kappa showed a substantial level of agreement, and it was categorized as "good" ($\kappa = 0.73$) (range 0.61–0.80) based on the categories developed by Altman [33]. A PRISMA flow diagram [32] is provided in Figure 1. All chosen studies were deemed to be of a sufficient quality to contribute equally to the thematic synthesis.

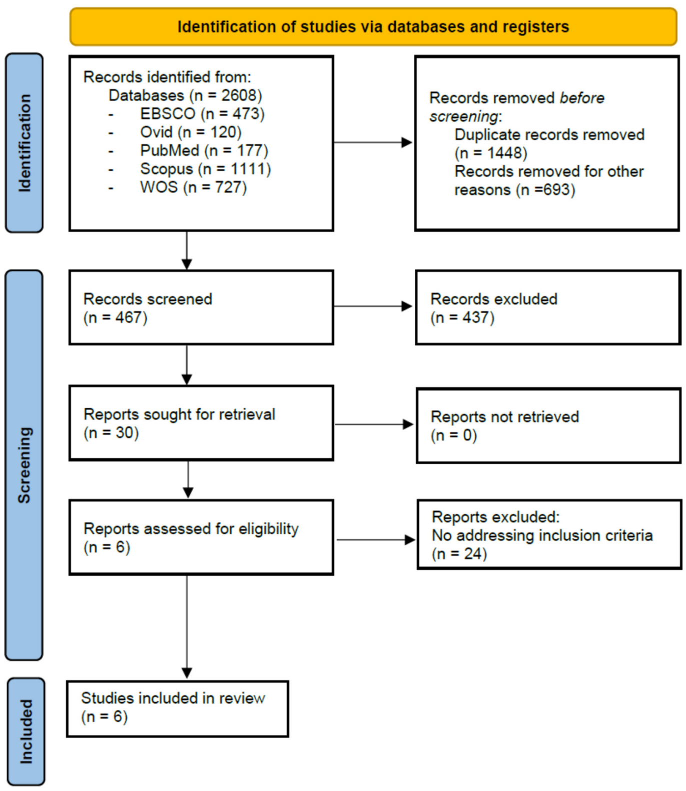

Figure 1. Systematic review of the literature flowchart.

3.2. General Characteristics of the Studies Included

Regarding points 1 (year of publication), 2 (country of the study) and 3 (study design), the following results were extracted (Table 1): the 6 selected studies were published between 2013 (n = 1; 16.7%) [60] and 2022 (n = 1; 16.7%) [64]. The majority of the studies were conducted in the United States (n = 4; 66.7%) [60,61,63,65]. The remaining papers were published in Australia (n = 1; 16.7%) [62], and Korea (n = 1; 16.7%) [64].

Table 1. General characteristics of included studies (n = 6).

Study	Publication Year	Country	Study Design
Chuah et al. [60]	2013	USA	Quantitative
Essmiller et al. [61]	2020	USA	Quantitative
Frost et al. [62]	2020	Australia	Qualitative
Murphy. [63]	2019	USA	Qualitative
Na et al. [64]	2022	Korea	Quantitative
Perryman et al. [65]	2021	USA	Mixed method

The studies involved followed a quantitative (n = 3; 50%) [60,61,64], qualitative (n = 2; 33.3%) [62,63], or mixed method approach (n = 1; 16.7%) [62] (Table 1).

Addressing points 4 (study aim), 5 (sample size and mean participants' age), 6 (college degree) and 7 (targeted mental health related variables), the following results were extracted: The objectives of the studies were extremely varied (Table 2). In 33.3% (n = 2) of the studies, the MR technique was used to interview child avatars [60,65]. Another study (16.7%) involved MR to mitigate cognitive load associated with its use in simple procedural tasks [61]. Other goals included using MR to explore the perceptions of need that health professional students from different disciplines formulated after a visual assessment of the same patient [62] or analyzing the effect of stress reduction [64]. Sample sized ranged from 13 [62] to 63 students involved [61]. There were some studies (n = 4; 66.7%) which did not provide the mean participant's age [61–63,65], two of which did not specify students' college degrees either [61,63]. Students involved were under diverse healthcare disciplines such as medical and nursing [60,62], physician's [60], occupational therapy, dietetics [62] and communication sciences and disorders [65]. The mental health related variable trained through MR was diverse, including interaction with a virtual patient and parents [60,65], and perceptions of a virtual patient´s needs [62] (Table 2).

Table 2. General characteristics of included studies (II) (n = 6).

Study	Study Aim	Sample Size (Mean Age)	College Degree	Mental Health-Related Variable Targeted
Chuah et al. [60]	To apply MR to simulate a pediatric developmental exam.	22 (25.45)	Health professions students (ten participants were undergraduate nursing students, seven were medical students, three were pediatrics residents, one was a graduate nursing student, and one was a physician's assistant student).	Interaction with a virtual patient (pediatrics) and parents.
Essmiller et al. [61]	How to facilitate instruction and practice with MR to mitigate cognitive load.	63 (not provided)	Not provided.	Motivation and self-efficacy.

Table 2. *Cont.*

Study	Study Aim	Sample Size (Mean Age)	College Degree	Mental Health-Related Variable Targeted
Frost et al. [62]	To explore the perceptions of need after a visual assessment of the same patient using MR.	13 (not provided)	Medicine (n = 3), nursing (n = 6), occupational therapy (n = 2), and dietetics (n = 2), in their last six months of training to get their college degree.	Perceptions of a virtual patient's needs.
Murphy. [63]	A seminar focusing on youth participatory action research (YPAR), to teach qualitative research using MR.	15 (not provided)	Not provided.	Ability to interact with younger students, interviewing them, and applying these skills to better develop qualitative research.
Na et al. [64]	To analyze the effect of stress reduction using an MR-based HAI.	30 (21.7)	Not provided.	Induced mental stress.
Perryman et al. [65]	To investigate whether MR enhanced perceived application of the content and increased confidence in specific clinician counseling skills.	29 (not provided)	Communication sciences and disorders (CSD) who had completed one full year of undergraduate.	Ability to apply clinical and counseling skills (e.g., delivering difficult news, paraphrasing, and normalizing difficult emotions).

3.3. Assessment of Methodological Quality of Included Studies

Extensive heterogeneity was found in the design of the studies as well as in the statistical methods used with diversity in the presentation of the results obtained. In many cases, randomization was not properly detailed, as well as main variables involved being (or not) manipulated by researchers (see Multimedia File S2).

3.4. Primary Outcomes

In relation to points 8 (training using MR), 9 (useful to acquire knowledge -theoretical concepts), and 10 (useful as training in new skills -practical concepts), the following results were extracted (Table 3).

MR training was use to address the following goals: To interact with a virtual patient (pediatrics) and parents to examine the effect of the object interaction interface on perception of the virtual child as a real one [60]; to play any game or simply use gestures or voice commands to navigate around their surroundings, while wearing the HoloLens (activity A was Roboraid, activity B was a Tutorial and activity C was Freeplay), spending 15 min in each experience [61]; to interact for a maximum of 15 minutes with an holographic simulated patient ('Holopatient') who was providing clear visual clues of her distress, breathing pattern, chest pain, and obvious discomfort that suggested she needed a referral [62]; to interact and observe student's avatar while one of the students was interacting, while the other ones (pair of students involved) were observing the simulation and taking observational notes [63]; developing a "Mental Arithmetic task" used to induce mental stress in the subjects, while MR content experience (interacting with virtual animals) or watching a slide show of animal images, were trained to compare which of them were able to make subjects feel more comfortable [64]; and finally using an actor-controlled avatar to practice collecting case history information and delivering diagnostic to parents of a child client, while developing interpersonal communication skills [65].

Surprisingly, there were no studies providing specific outcomes regarding the student´s acquired knowledge (theoretical concepts) after using MR (Table 3). However, regarding MR usefulness as a training to develop new student´s skills (practical concepts), several outcomes were mentioned. As such, increases in the participant's confidence levels were found, both as indicators of the exam's educational benefit to improve concrete skills (interviewing a parent, interacting with a child, and assessing a child's development) [60]; as well as in their confidence levels for managing information exchange such as avoiding false reassurances, making sure patients understood the information presented, and inviting questions and concerns [65]. Additionally, increases in the participant's perceived abilities to apply counseling skills were mentioned, such as listening skills (e.g., paraphrasing information), providing selective feedback (e.g., reframing negative perspectives and normalizing difficult emotions) to parent avatars [65]. However, in another study no significant differences were found between the targeted mental health related variables (motivation and self-efficacy), and the type of activity performed by students using MR (A, B or C) [61]. When asking to detect nuclear cardiac symptoms while interacting with the avatar, only two participants recognized the potential of the patient's symptoms being cardiac, and only three of them suggested that an immediate referral for this patient was appropriate [62]. Perhaps the MR condition has been shown to be an effective tool to relieve tension in students [64].

Table 3. Primary outcomes (n = 6).

Study	Training Using MR	Useful to Acquire Knowledge	Useful as Training in New Skills
Chuah et al. [60]	Interaction with a virtual patient (pediatrics) and parents to examine the effect of the object interaction interface on perception of the virtual child as a real child.	Not provided	Yes
Essmiller et al. [61]	Using Microsoft HoloLens, via three different activities: (a) a 3D AR gamewhere players defend their homes from a robotic invasion (Roboraid); (b) a Microsoft tutorial on how to use the HoloLens and (c) freeplay, where the participants are free to examine any content from the HoloLens, to explore and observe the engagement of the participants in the assigned activities.	Not provided	No
Frost et al. [62]	Participants were asked to spend a maximum of 15 min immersed in an application that displayed a holographic patient (Holopatient.), via Microsoft Hololens: a head mounted wearable holographic headset which permits human-computer interaction within an MR environment.	Not provided	Yes
Murphy. [63]	A 10-min training session on the SHOWeD protocol through a photovoice discussion in a classroom of the Mursion. MR was used in the interaction with five avatars that simulated five eighth-grade students, diverse in personality.	Not provided	Yes
Na et al. [64]	A 3 min training session using MR, with virtual animals (cats), with gestures and voice commands, using HoloLens (1st generation).	Not provided	Yes
Perryman et al. [65]	Utilizing an office environment with adult avatars, to simulate a meeting between a student clinician and a patient. There were two challenges: (1), two parents were presenting with the lead participant in a post assessment meeting for their 4-year-old son who was exhibiting social communication delays, language deficits, and atypical behaviors; and (2) the same two parents returned for follow-up consultation where participants' objectives were to plan for intervention.	Not provided	Yes

3.5. Secondary Outcomes

As regards points 11 (main advantages and disadvantages), and 12 (student´s satisfaction), the following results were extracted (Table 4): In general, all the studies (n = 6; 100%) pointed out several strengths and weakness of using MR with students.

Table 4. Secondary outcomes (n = 6).

Study	Main Advantages and Disadvantages	Student's Satisfaction
Chuah et al. [60]	Yes	High
Essmiller et al. [61]	Yes	Not provided
Frost et al. [62]	Yes	Not provided
Murphy. [63]	Yes	Not provided
Na et al. [64]	Yes	Not provided
Perryman et al. [65]	Yes	High

Among the advantages mentioned, MR represents a technology which successfully created virtual humans (as simulated children) that users perceived and treated realistically, while they were able to elicit realistic behavior from the students [60]. MR was also helpful to achieve meaningful learning experiences by using Microsoft HoloLens [61]. Additionally, the possibility of developing simulations with vulnerable population (such as the intellectually disabled) while being safely practiced with virtual avatars, and to practice exams and experience exposure to a wider variety of children and parents [60]. The use of MR also allowed different disciplines to view the same patient, demonstrating the potential of MR for interprofessional learning, and permitting to highlight the disagreements between different health professional students [62]. In addition, a unique benefit of MR has been highlighted as it can be utilized in an asynchronous yet consistent manner, to allow various health disciplines to explore the same simulated experience without the difficulties of scheduling [62].

MR has been mentioned as a scaffolded learning tool to practice with student avatars prior to working with real students, while showing them the necessity to learn how to improvise along the simulation [63]. MR simulations have been pointed out as capable technology for reducing mental stress among university students [64]. It can be a useful tool for teaching interpersonal communication and counseling skills for students, including undergraduates, while increasing their perceived self-efficacy as "*simulation provided them with knowledge that they can apply in real clinical settings*", "*to prepare and support students as they enter a professional field*", "*as an effective option for preclinical training*", "*gave them more confidence for applying counseling skills*", "*provide learners with a safe space in which they can practice skills, while their mistakes in this scenario did not harm a real person*" [65].

Included studies have referred to several disadvantages, after using MR with students. Their usability was pointed out, by meaning "*many people have difficulty with computers, and these people can be intimidated by relatively cutting-edge technology such as mixed reality and virtual humans*" and "*not computer savvy at all, so if I can figure it out, anyone can figure it out*") [60], and some "*students noted that interacting with the avatar was sometimes challenging*" [65]. The avatars (parent's) appearance and their behavior as being not realistic enough ("*the parent never interjected in the exam and overall seemed less involved than a real parent*") and asking for "*making object interactions more realistic and physical but instead on making virtual human behavior more realistic*" [60]. The MR simulations were not able to directly measure whether students' skills will be improved when they must develop them in a real face-to-face setting [65]. Few educational institutions could afford MR as a training tool for their students, due to the high cost of licensing and the space required for lab practice [65].

Only two studies (33.3%) provided information relating student´s satisfaction after using MR [60,65].

4. Discussion

The use of MR technology to train specific skills in undergraduate healthcare students is still in its infancy. For that reason, the present study aimed to answer two key questions: (1) if MR could be considered as a useful tool for enhancing knowledge acquisition and skill training in undergraduate mental health students; and (2) which are the main advantages and disadvantages that should be addressed to successfully develop MR strategies in mental health education.

4.1. MR Usefulness to Enhance Acquisition of Knowledge/Skills in Mental Health Education

Perhaps there were no studies addressing acquisition of knowledge after using MR, mixed-reality clinical simulation scenarios could easily integrate into a standing course to help students apply knowledge and meet course objectives even at the undergraduate level [65].

The mixed-reality clinical simulation scenarios can be designed to help the development of interpersonal skills, or soft skills [65], such as interviewing a parent or interacting with a child [60], and even more, achieving a high student satisfaction after developing this kind of training [60,65], reported as "*MR exam was educationally beneficial and something they would like to use again*" [60].

Together, this suggests mixed-reality clinical simulation scenarios may be a valuable tool for developing soft skills, such as counseling skills, which are extraordinarily relevant for mental health practitioners. Results suggest that both students' perceived abilities and confidence levels to implement and practice skills were increased because of their participation in MR simulation [65], as other authors have previously mentioned [6,14,15].

4.2. MR Advantages and Disadvantages in Undergraduate Mental Health Education

MR involves some benefits for healthcare practitioners, such as the ability to provide patient care as a remote service. For example, in mental healthcare environments, the psychologists or psychiatrists could provide their professional care by allowing the selected patients to be together virtually, as virtual support groups, even when they are not together physically. This is also possible considering that patients could reach the best specialist who is living in another place, and they could benefit from their care, thanks to MR. It is particularly useful considering patients with reduced mobility, or under pandemic conditions, as has been the case worldwide over the past few years. In this sense and considering that the studies included were published in the last decade (2012–November 2022), perhaps, because only one study was published prior to the appearance of COVID-19 [60], its objective was focused on training various professionals in relation to a pediatric interview. However, the remaining studies, published during the pandemic, contemplate objectives more related to faster/more efficient health care service provision, such as to explore the perceptions of need after a visual assessment of the patient [62], stress reduction [64] or clinical counseling skills [65]. ERs, such as VR and AR, have been successfully used for the assessment and treatment of mental disorders [66]. This technology allows patients to interact with a feared situation, but in in safe environments [65], and under strict clinician supervision (monitored and controlled).

As a result, implementing MR techniques with mental health patients may lead to reduction in cost for the patients as well as for healthcare providers, while allowing a better health care.

Moreover, the MR allows all patients and clinicians to converge in the same reality (virtual or physical), to be able to receive adequate treatment or to discuss the best treatment that could be provided to a singular patient. Moreover, it also allows the psychologists or psychiatrists to be monitoring their patients in real time, while they are practicing some of the difficult techniques they should learn, such as visualization, meditation, or abdominal relaxation. In that way, the clinicians could be reassured that the patients are practicing the techniques in an appropriate way and avoiding, as very commonly happens, that the patients just struggle with the techniques, and eventually decide just not to practice them anymore. The possibility of monitoring the patients in real time means more easily tracking factors such as compliance. This could even be improved through using wearables. As such, the patients could use different types of body sensors (wearables) in addition to an MR headset, to control their own avatar with their entire body, increasing the immersive experience by meaning the sense of "being present" [8,19,20], and therefore achieving all the related secondary benefits in their learning process.

All previously mentioned methods could be applied to education, as mental health undergraduate students could benefit from non-presence education, developed through MR in an asynchronous yet consistent manner, to allow various health disciplines to explore the same simulated experience without the difficulties of scheduling [62]. As such, the students could be physically separated but virtually connected, for example using technology such as Metaverse, which already encompasses MR, and, for example, all receiving a Master class of a reputed Full professor or specialist who is physically in another part of the world. Similarly, the students could also take advantage of learning together physically in the same classroom, by using MR [63]. In that sense, one of the students could be developing the simulation (i.e., how to better develop counselling skills after a patient's panic attack), while he/she will be watching the avatar patient, and also interacting with him (touching, hearing him, etc.) and observing the results. The rest of the classmates could be watching the same reality, displayed on a common screen, without the necessity of wearing the hardware (HoloLens2), and just by looking at the classroom screen or their smartphones screens (in case of not being physically present in the classroom).

In that way, they all benefit from this kind of training. As using new technology during simulations is an attractive innovation for many students, resulting in enhancing their learning experience and perceived self-efficacy [13], their engagement [13,16,17], their enjoyment [18], their user satisfaction level [6,13,26,27,60,65] and the quality of the teaching and learning process [15] means that MR could be really useful as a training tool for undergraduate mental health students, by increasing their willingness to acquire real knowledge [7], increasing their practical skills [6,14,15] compared with traditional teaching models [6] and consequently improving their final performance [15]. VR has also been mentioned as a helpful tool when used by students with Autistic Spectrum Disorders [67].

Another advantage that MR could provide to mental health educators is the ability to develop "health digital twins" (HDT) by meaning "*a virtual representation (digital twin) of a patient (physical twin) that is generated from multimodal patient data, population data, and real-time updates on patient and environmental variables*" [68]. Using this virtual representation, patients´ avatars have been already demonstrated to be beneficial for treating some chronic patients [69] by reducing anxiety and depression symptoms and improving variables such as quality of life, knowledge, and self-care behavior. In fact, the avatar-based technology geared towards educating patients was shown to have a positive effect on the knowledge and self-care behaviors in chronic illnesses [68]. Moreover, personalizing avatars to bear a resemblance to users increases the probability that patients adopt healthier behaviors [10,70], so the more embodiment the avatar has [6,71] the better results for the patients. As such, the embodiment has proven to be an advantage for many patients.

In the same way, the mental health undergraduate students could benefit from this reality, by getting their own avatars (high embodiment), which allow them the sense of "being there", by meaning being themselves (avatar) in front of the patients with depressed or psychotic diagnostics, along a clinical simulation. Using this MR, the own student could develop the clinical simulation (i.e., how to manage a patient who is attending an emergency room because he/she has suffering visual and auditory hallucinations symptoms as a result of cannabis consumption), while developing the required clinical skills. The rest of the classmates could also be watching the scene, without needing to wear the HoloLens2, just looking at the classroom screen, or even, different students attending the same subject but in different locations (i.e., colleges with more than one campus), could be attending the same lesson together, as MR allows to create a communal virtual world by having several users wearing multiple headsets, such as HoloLens2. As the simulations can be verified from video recordings of practice procedures, the students could see themselves (their avatars) after performing the assigned exercise, and this represents such a valuable resource to educators, due to allowing them to provide and accurate feedback of the student´s performance during simulation. Furthermore, the possibility of students to watch themselves while developing the simulation could allow them to realize some important concerns in mental health care, such as students body language (nonverbal language), and even their tone of voice or the vocabulary used during the simulation (it will be the same but displayed through the avatar). It could replace the traditional video recording that academic staff used in the past, during students' simulation, achieving a technology that represents a great opportunity to realize strengths and weakness in your own performance, while discovering by yourself.

Some of the MR barriers mentioned in the included studies are their usability [60,65], as previously authors have pointed out by referring the difficulty of using the device, accessibility issues, the lack of flexibility, affordances, and fatigue [8]. Another challenge is the security of data [59] or enabling the full potential of this technology in healthcare educations, due to its requirement for expensive high-tech hardware such as glasses (HoloLens2), gloves, sensors, and other wearables that can read patients' vital signs. Some of MR hardware is still expensive, as mentioned in the included studies [65]. Ergonomics criteria should also be considered, such as perception and muscle fatigue after using HoloLens or similar devices. The whole society cannot afford it, so this technology is limited to those universities, educational institutions, and hospitals which can manage to pay for it. As reaching an appropriate interoperability is a critical component of today's healthcare paradigm, another investment should be made to cover this requirement, as well as to achieving more realistic avatars which could lead to more real perceived interactions [60]; considering the previously mentioned benefits, depending on the type of avatar used [68].

From a mental health practitioner's point of view, the MR as other related technologies (AR, VR or metaverse), has been pointed out as potentially damaging to users due to excessive immersion, which could lead the users to experience identity confusion, lack of interest in the real world [72], loneliness and temporarily isolation [73]. The possibility of developing addiction because of using virtual realities has also been pointed out [59]. Additionally, it was discovered that increased loneliness and depression, anxiety, social fears and poor academic performance are more likely to be the aftermath of addictive behavior than to be the cause of it [74]. There is a need to figure out the possibility of developing addiction disorders and related concerns in students, after using MR technologies in undergraduate education, as knowledge of potential damages after its use is still poor [27].

As there is still a scarcity of standardized protocols on the type of results and evaluations obtained in RCT applying ER to the education [1], and this aspect has been previously noted by determining the effectiveness of applying digital tools to educational setting of healthcare environment [7,28,29], further research is needed to validate existing simulators and to verify whether improvements in performance on a simulated scenario translate into improved performance on real patients [75].

5. Conclusions

In accordance with the objectives proposed and the results obtained in this systematic review, the following conclusions may be reached:

(1) There is not enough empirical evidence to be able to assure that MR is an effective technology to enhance the acquisition of knowledge and skill training in undergraduate mental health education, due to the lack of studies targeting this topic.

(2) Taking into account the different MR techniques developed with students, several advantages and disadvantages, as previously mentioned, should be addressed in order to successfully develop MR strategies in mental health education.

In the present study, there were no studies applying MR in traditional undergraduate mental health education such as the one needed to obtain a degree in Psychology. Only mental health-related variables were targeted to be trained by using MR, in other healthcare students. Moreover, there is also a lack of evidence in the literature regarding the learning outcomes of immersive technologies as educational tools for teaching college-level healthcare students [13].

It is imperative to develop accurate studies which allow us a clear understanding of drivers and barriers that students may encounter when learning in a MR environment [8], and the creation of standards and rules for implementing MR technologies in educational settings [76], especially in undergraduate mental health education.

Authors of the present study, as researchers involved at Psycho-Technology Lab (Universidad San Pablo-CEU, Madrid-Spain), fully support the words of Kristin M. Murphy [63]: "*The body of literature exploring the application of MRS as a tool for active learning is still young. I encourage you to think about how learning with avatars may serve as a valuable scaffold for you and your students on their pathway to experiences in the real world. I look forward to learning from you*". For that reason, since 2019, we have hardly been working on an innovative MR software, which could help our undergraduate mental health students to better understand the meaning of helping patients, before they should develop the required skills with real patients.

5.1. Clinical and Researcher Implications

Future randomized controlled trials are needed to determine the following remaining questions: Does the effectiveness of MR strategies depend on the type of healthcare studies involved (i.e., Medicine, Psychology, Nursing)? Are there specific modalities of MR strategies which may produce a higher enhancement, engagement, and skills acquisition in healthcare students? In mental health care students, are there modalities of MR that may produce a greater level of students' satisfaction? Why? Do some psychological variables or specific clinical skills benefit more from the use of MR technologies? Will the improvement be the same using MR rather than using, for example, the Metaverse? Is there any potential damage for students after using MR in undergraduate healthcare education?

Due to the extreme scarcity of studies which apply MR technology to mental health education, further studies are needed, because their results could improve not only the students' skills, but also the quality of the healthcare services provided to mental health patients.

5.2. Limitations

The main limitations of this study include the lack of studies involving MR in undergraduate mental health education, as well as the great methodological heterogeneity of the papers included. This hinders the uniformity of the results, as well as their generalizability. As the goal was to analyze the existing literature published in the last decade (2012–November 2022), another potential limitation maybe the occurrence of COVID-19 during this period. Furthermore, the countries in which the included studies were carried out were mainly developed countries, rather than developing countries. Therefore, in order to produce meta-analyses that provide conclusive results on the effectiveness of this approach, greater homogeneity in the targeted students as well as in the methodology used, dates and countries in which were developed would be desirable.

Likewise, the devices used for MR are undergoing significant and rapid advancement, so the studies made regarding their advantages and disadvantages should be updated and renewed according to the latest technological developments.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/electronics12041019/s1, Multimedia File S1: Study protocol. Multimedia File S2: Quality assessment of included studies (MMAT). Multimedia File S3: Reasons for studies exclusion.

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