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Steffen Massanneck

`steffen.massanneck@fau.de`

Friedrich-Alexander-Universität Erlangen-Nürnberg

Johanna Sader

Anja Pascher

Friedrich-Alexander-Universität Erlangen-Nürnberg

Lennart Seizer

LMU Klinikum

Lena Kubitschek

Friedrich-Alexander-Universität Erlangen-Nürnberg

Matthias Berking

Friedrich-Alexander-Universität Erlangen-Nürnberg

Fanny Dietel

Friedrich-Alexander-Universität Erlangen-Nürnberg

Johanna Löchner

LMU Klinikum

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Steffen Massanneck^{1*}, Johanna Sader, Anja Pascher^{1,2},
Lennart Seizer³, Lena Kubitschek¹, Matthias Berking⁴,
Fanny Dietel¹, Johanna Löchner³

¹Clinical Psychology and Psychotherapy for Children and Adolescents, Friedrich-Alexander University Erlangen-Nürnberg, Erlangen, Germany.

²Department of Child and Adolescent Psychiatry, Psychosomatics and Psychotherapy, University Hospital Tübingen, Tübingen, Germany.

³Mental Health in Primary Care, LMU University Hospital, Munich, Germany.

⁴Department of Clinical Psychology and Psychotherapy, Friedrich-Alexander-University Erlangen-Nuremberg, Erlangen, Germany.

*Corresponding author(s). E-mail(s): Steffen.Massanneck@fau.de;
Contributing authors: johanna.sader@web.de; Anja.Pascher@med.uni-tuebingen.de; lennart.seizer@med.uni-tuebingen.de;
leni.kubitschek@fau.de; matthias.berking@fau.de; fanny.schober@fau.de;
Johanna.Loechner@med.uni-muenchen.de;

Abstract

Purpose: This study investigates the feasibility and user experience of a prototype Virtual Reality (VR)-based therapy application. This application is designed to treat depression and anxiety in adolescents. It also elicits design requirements to inform the development of future VR psychotherapy applications.

Methods: To assess feasibility, user experience, engagement, and requirements, a Mixed-methods Pilot Study was conducted. Participants were 20 adolescents and young adults (80% female; M (SD) = 18.95 (1.90)) and three therapists. These 23 participants took part in a 60-minute interview consisting of an application test comprising three modules and a sham condition. After each module,

the User Experience and mental health scales were measured. The application test was followed by an interview to gather additional feedback and identify requirements for the final application. **Results:** While no effect on positive mental health (emotional, psychological, and social well-being), measured with the Positive Mental Health Scale, was found, participants reported reductions in school-related anxiety, stress, and negative thoughts. The user experience of the three modules was rated positively (User Experience Questionnaire (UEQ-S) M (SD) = [5.86; 6.47] ([0.39; 1.04])) and was on par with the sham condition (UEQ-S M (SD) = 6.41 (0.45)). The interview revealed that an application designed for adolescents should feature natural environments, a user-centered design with more detailed instructions, a wide range of scenarios, interactive options, and accessibility. **Conclusion:** This study highlights the potential of a remote VR application for treating and preventing depression and anxiety among adolescents and young adults.

Keywords: Virtual Reality, Depression, Intervention, Adolescents

1 Background

Adolescence constitutes a vulnerable period for the development of the most common mental health disorders, e.g., anxiety and depression, with prevalence rates amounting up to 8% during this time (Radez et al. 2022; Polanczyk et al. 2015; Sadler et al. 2018; Lawrence et al. 2015; Merikangas et al. 2009). Thus, adolescence is also considered an important phase for prevention, as 51.8% and 13.2% of adolescents are affected by anxiety and depression, respectively, before the age of 18 (Solmi et al. 2022).

Importantly, depression is associated with increased suicidality and other detrimental health outcomes, including lower self-perceived general health (Keenan-Miller et al. 2007; Schaffler et al. 2022), thus contributing to the substantial individual, societal and public health burden associated with the disorder. Depression and anxiety cost the global economy one trillion US dollars each year (Cuijpers et al. 2023; WHO 2016). Overall, these impacts underscore the pressing need for early interventions to prevent and treat further mental health disorders.

Despite this burden, only two-thirds of adolescents with anxiety or depressive disorders experience barriers in accessing treatment, and only a minority seek specialist mental health support (Radez et al. 2022; Sadler et al. 2018; Lawrence et al. 2015). More specifically, treatment barriers include limited service provision and long waiting times (Sadler et al. 2018; Merikangas et al. 2009; Lawrence et al. 2015). Additionally, adolescents have been shown to experience high levels of mental health-related shame and stigma, all of which impede help-seeking and delay treatment (Radez et al. 2022). A systematic review (Radez et al. 2021) has shown that 76 percent of studies report fear of stigma as a barrier to psychotherapy. Together, these barriers emphasize the urgency for low-threshold and timely preventive interventions. Because public health systems in many countries are already strained, scalable interventions that require

little or no personnel resources are highly preferred. Another critical need for adolescents may be access to specialized therapies, such as novel and interactive therapies (Baldofski et al. 2024; Dietvorst et al. 2024).

One promising approach to offer such a novel, engaging, interactive, and low-threshold treatment may lie in the utilization of Virtual Reality (VR), which is particularly appealing for young people. Overall, VR encompasses "...immersive technologies to simulate interactive virtual environments or virtual worlds with which users become subjectively involved and in which they feel physically present" (Wohlgenannt et al. 2020). Current consumer-grade VR systems consist of VR headsets with head-mounted displays (HMD). The VR HMD provides visual, auditory, and peripheral tactile stimuli to simulate the real world and create a feeling of presence (Kim and Kim 2020; Dinh et al. 1999; Slater 2009). In recent years, VR headsets have become more affordable, and a multitude of standalone models are now available, enabling use without expensive computers (Grand View Research 2023). Therefore, current standalone VR headsets seem to be an excellent option for providing blended and remote therapy in patients' homes. Furthermore, as digital natives, adolescents tend to be technologically savvy in using new technology and are more likely to share emotions in clinical therapy through images, text, or video than through spoken language (Shamri Zeevi 2021; Kim and Chung 2023).

Although VR has been used in psychotherapeutic practice since the 1990s, research and practice are still mainly focused on the exposure-based treatment of phobias, e.g., agoraphobia, social phobias, and fear of flying (Valmaggia et al. 2016; Freitas et al. 2021). However, recently, the number of application scenarios has begun to increase, and VR is now being used for various other mental health disorders with robust efficacy, such as Attention Deficit Hyperactivity Disorder (ADHD) (Bioulac et al. 2020; Tabrizi et al. 2020), aggressive behavior in children (Alsem et al. 2023), anorexia nervosa (Porrás-García 2020), social skills (Kahlon et al. 2024; Wong et al. 2024). VR applications are especially useful for practicing social skills because they can offer a less aversive training opportunity while maintaining a high sense of presence and immersion (Mittal et al. 2024; Romero-Ayuso et al. 2021). Despite this diversification of research contexts in adults, research on VR application in children and adolescents remains scarce. Critically, there is a lack of literature on treating anxiety and depression with VR in this population (Massanneck et al. 2026), despite evidence on the design of VR prototypes and evaluation processes (Turan Akdag et al. 2023; Massanneck et al. 2024).

To address this gap, we developed a VR prototype application for targeting adolescents with depression. To enhance usability and acceptance, and as part of a participatory research process (Vaughn and Jacquez 2020), we co-created this VR application with adolescents, young adults, and therapists, focusing on treating early signs of anxiety and depression to bridge long waiting times. Further, this application was designed to target well-established, evidence-based factors integral to depression prevention, including resilience (Ma et al. 2020), introspection (Hofmann et al. 2010), social skills (Segrin 2000), and emotion regulation skills (Jahangard et al. 2012).

Hence, this study presents the first step in the design and development process for the final application. Therefore, the primary objectives of this study were to investigate

Table 1 Demographic variables (Therapist Group)

	Total Sample (N=3)
Age in years, M (SD)	31.33 (2.89)
Gender, n (%)	
Female	3 (100%)
Male	0 (0%)
(Privat) Experience with Virtual Reality, n (%)	
No experience	3 (100%)
Some Experience (less than 10 hours total usage)	0 (0%)
Experience (>10 hours total usage)	0 (0%)
(Professional) Experience with Virtual Reality, n (%)	
No experience	3 (100%)
Some Experience (less than 10 hours total usage)	0 (0%)
Experience (>10 hours total usage)	0 (0%)

the feasibility, user acceptance, and user experience of the developed prototype from the perspective of future users (adolescents); explore first effects on positive mental health, stress, anxiety, and negative thoughts; and gather requirements and feedback from a therapeutic perspective. As a secondary objective, this study investigated how a virtual therapy environment should be designed for adolescents.

2 Methods

2.1 Participants

In total, $N = 23$ participants were recruited for this study. To capture both patient and therapist perspectives on the developed prototype, we interviewed adolescents ($n = 20$) and therapists ($n = 3$). For the first group (i.e., adolescents and young adults), participants were mainly recruited through posters at the *University Outpatient Center for Psychotherapy* in Erlangen, Germany, and through a mailing list at the University of Erlangen-Nuremberg. The Inclusion criterion was: aged 13-24 years.¹ There were no other inclusion or exclusion criteria. Additionally, we assessed whether participants had prior experience with psychotherapy and experience with VR (see Table 1 and 2). We conducted individual interviews with adolescents and young adults between October 2025 and February 2026. For the second group (i.e., therapists), licensed psychotherapists were recruited through various departments and university outpatient centers in Erlangen, Germany. Interviews took place between October 2025 and February 2026. For participating in the evaluation and questionnaire, participants received a 15-euro gift card for their time, and psychology students could choose to receive research participation credits instead.

Table 1 shows the characteristics of the therapist group.

Table 2 shows the characteristics of the adolescent group.

¹The final study will have an age range from 13 to 17 years. However, to allow for more diverse feedback, we also included young adults, following the WHO-definition, up to 24 years ([World Health Organization, Regional Office for South-East Asia \(SEARO\) 2019](#)). In addition, as per national law in Germany, psychotherapy for children and adolescents can continue until age 24 to support therapy success. Thus, young adults represent a pertinent group within the target population for this VR application ([GemeinsamerBundesausschuss 2026](#)).

Table 2 Demographic variables (Adolescent and Young Adults Group)

	Total Sample (N=20)
Age in years, M (SD)	18.95 (1.90)
Gender, n (%)	
Female	16 (80%)
Male	4 (20%)
Experience with Virtual Reality, n (%)	
No experience	7 (35%)
Some Experience (less than 10 hours total usage)	12 (60%)
Experience (>10 hours total usage)	1 (5%)
Experience with Psychotherapy, n (%)	
No experience	12 (60%)
Experience	8 (40%)

2.2 Ethics

All participants provided written consent for conducting and publishing the results of the interviews. For participants under 18 years, the parents also provided written consent. The study was conducted in compliance with the Declaration of Helsinki. This study served as a pilot for a subsequent study, which was approved by the Ethics Committee of the Medical Faculty of LMU Munich.

2.3 Design

To address the research questions and evaluate the prototype, we used a mixed-methods design. As the primary objectives, we investigate the feasibility, user acceptance, and user experience of the developed prototype from the perspective of future users and gather feedback from therapists. As a secondary objective, we investigate how a virtual therapy environment should be designed for adolescents.

The participants tested three modules of a VR intervention and a control-condition game. After the intervention, they answered questions related to user experience, positive mental health, and the modules content. To complement these quantitative assessments and to explore more detailed feedback on usability and application design, a semi-structured qualitative interview was conducted afterward.

There were two separate interviews: one for adolescents/young adults and one for therapists. Furthermore, the Positive Mental Health (PMH) Scale (Lukat et al. 2016) was assessed before and after each control condition (module and sham condition), as well as the UEQ-S (Schrepp et al. 2017) (see detailed description below). Lastly, after each module, two questions related to the module’s goal were assessed. For the therapist group, a slightly adapted semi-structured interview was used, omitting the PMH and placing greater emphasis on the application design.

A within-subject randomized controlled trial (RCT) was used to measure the preliminary effects of the three modules on the participants. Each module was treated as a separate group. Additionally, a sham condition was used, where the participants used the "First Steps for Meta Quest" Application. For assessing the PMH a pre-assessment was treated as a fifth group. The order of the four conditions (Module 1,

Module 2, Module 3, Sham condition) was randomized and inter-individual balanced to minimize sequence, order, and carryover effects.

After the application test in the second-interview section, they were asked which type of virtual therapy room they preferred.

2.4 Measures

2.4.1 Demographic Characteristics

First, the demographic data were measured, which included age and gender. The adolescents were asked whether they had any prior psychotherapy or VR experience. The psychotherapists were asked if they had had private VR experiences or if they had experience accelerating VR in their own therapy sessions.

2.4.2 Module Characteristics

The adolescents/young adults survey had two parts. After answering questions about demographic data and prior experience the participants tested the VR application. This was important so they would have an idea of what the future application could be like and could provide higher-quality feedback. This part mainly focused on the perceived user experience, feasibility, user engagement, and positive and negative impressions of the application.

Additionally, for each module, there was one item on a 7-point Likert scale to assess whether the module fulfilled its goal, followed by an open-ended question about how the applications should be adapted to better achieve this goal. For module 1: "How much, do you think, this exercise can help you cope with negative thoughts in a school context?" For module 2: "How much did this exercise help you relax and relieve stress?" For module 3: "How much did the exercise help you relieve your negative thoughts and self-beliefs?"

The follow-up question for each module was "What would you change to improve this?".

2.4.3 User Experience

For measuring user experience a mixed-methods approach was used. For quantitative data, we used the German version of the UEQ-S from [Schrepp et al. \(2017\)](#). To enrich this with qualitative data, we conducted semi-structured interviews (see Section 2.4.5). The UEQ-S was assessed after each condition to differentiate the user experience across modules.

The UEQ-S is a 7-point semantic differential consisting of eight items, instead of 26 in the full version ([Schrepp et al. 2017](#)).

2.4.4 Positive Mental Health

To assess effects of the three models, the Positive Mental Health Scale was used ([Lukat et al. 2016](#)). The PMH was assessed before the treatment and after each module, i.e., five times in total. It is a self-report questionnaire consisting of nine items that measures positive mental health and is assessed on a 4-point Likert scale from 0 (do

not agree) to 3 (agree) (Lukat et al. 2016). Higher scores reflect greater positive mental health in the areas of emotional, psychological, and social well-being (Lukat et al. 2016). Exemplary items are "I am in good physical and emotional condition", "All in all, I am satisfied with my life" and "Much of what I do brings me joy".

2.4.5 Application Design

The types of VR therapy rooms and applications that would be appreciated by both participant groups were investigated by developing a questionnaire with various item categories. In a first step, a systematic literature search was conducted to gather requirements for a VR therapy room, the interactions within it, and relevant factors. We used the following search string "*Virtual Reality*" OR "*VR*", "*Mental Health*" OR "*Mental Disorders*" and "*Design*" OR "*Layout*" OR "*Architecture*" in the databases Psynex, APA PsycInfo, PubMed, GoogleScholar and IEEE Xplore. The various requirements were analyzed and condensed into five categories. The following five categories with corresponding items were derived: Atmosphere and connection to Nature, User-Centered Design, Interaction and Learning, Accessibility, and Information and Data Privacy.

The first category, "Atmosphere and Connection to Nature," was grounded in empirical findings indicating the positive impact of nature on mental health. More specifically, according to Gentile et al. (2023) and Zaharuddin et al. (2022), nature-based design elements such as water, plants, and natural materials could help create a calming environment and reduce anxiety and stress. This was also described in Wilson (1986) biophilia theory and in Kaplan and Kaplan (1989) attention restoration theory: Humans tend to have an innate and evolutionarily developed tendency to seek a connection with nature. In addition, designing the VR environment to be as realistic as possible also seems to enhance immersion and lead to a positive and helpful VR experience (Khosrawi-Rad et al. 2024; Wechsler et al. 2019; Zaharuddin et al. 2022).

The second category, "User-Centered Design", was chosen because several studies have shown that ease of use and a clear user interface increase the acceptance of VR (Turan Akdag et al. 2023; Khosrawi-Rad et al. 2024). In addition, customization options and flexibility may play a central role in achieving a positive user experience (Turan Akdag et al. 2023; Sinclair 2021).

The third category, "Interaction and Learning," encompasses interactive design elements, such as the manipulation of virtual elements or avatars. Interactivity could help to ensure that patients are actively involved in the therapeutic process (Lindner et al. 2019; Wagener et al. 2023). This can also promote patients' therapy motivation (Lenz et al. 2020).

The fourth category, "Accessibility", includes studies on the conditions for successful VR therapy, including barrier-free access, uninterrupted sessions, and practical feasibility. The included studies emphasize that barrier-free therapy options and undisturbed sessions are key quality characteristics (Khosrawi-Rad et al. 2024). A distinction is made regarding usage contexts between VR applications that could be performed independently, which seem to be more cost-effective and more widely applicable, and VR applications that need therapeutic supervision (Pira et al. 2023).

Table 3 General Questions pertaining to the VR application design

Categories and Items
Category 1: Atmosphere and Connection Nature
- Would you prefer to undergo therapy in nature or in a sheltered room?
- If in nature: How should the natural environment be designed?
- If in a room: - How should the VR room be designed for you to feel comfortable and safe?
Category 2: User-Centered Design
- Are there any aspects of VR operation that are particularly important to you?
Category 3: Interaction and Learning
- Would you prefer to observe passively or actively participate in the VR experience?
Category 4: Accessibility
- How important is it to you that you can move freely in VR without disruptions or distractions?
- If not mentioned: What might distract or bother you in the VR environment?
- Would you prefer to use VR alone or with your therapist in a safe environment?
Category 5: Information and Data Privacy
- How important is it to you that your personal information and actions within VR remain secure and private?
- If not mentioned: What specific details would need to be explained for you to feel secure?
Closing Question
- Is there anything else that would be particularly important to you when using a VR therapy environment?
- Do you have any additional suggestions for features that should definitely be included?

The fifth category, "Information and Data Privacy", includes studies that examine the secure and transparent handling of personal data, as well as the protection of privacy when using VR applications (Turan Akdag et al. 2023; Khosrawi-Rad et al. 2024). The studies emphasize the need for clear and understandable information about data processing and highlight specific data protection risks associated with the collection of sensitive information, such as data related to avatars or communications (Dick 2021).

The following Table 3 shows the categories and corresponding items of the questionnaire and Figure 1 provides an overview of the project steps.

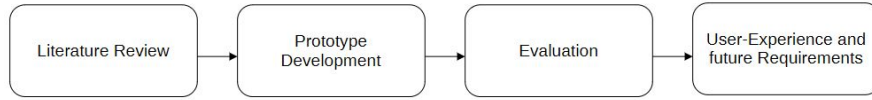
**Fig. 1** Pilot Project Flowchart

Figure 2 shows the detailed flowchart of the interview sessions for each participant.

The interviews closed with an open-ended question about whether participants had any further comments on the applications.

2.5 Intervention

As part of prototype development, participants evaluated the VR application via a Meta Quest 2 VR headset. The application was designed to run on Meta Quest devices because they are the most widely used and affordable headsets, priced between \$300 and \$500 (Statista 2023). We used the Unity Game Engine Version 6000.0.47f1 (Unity

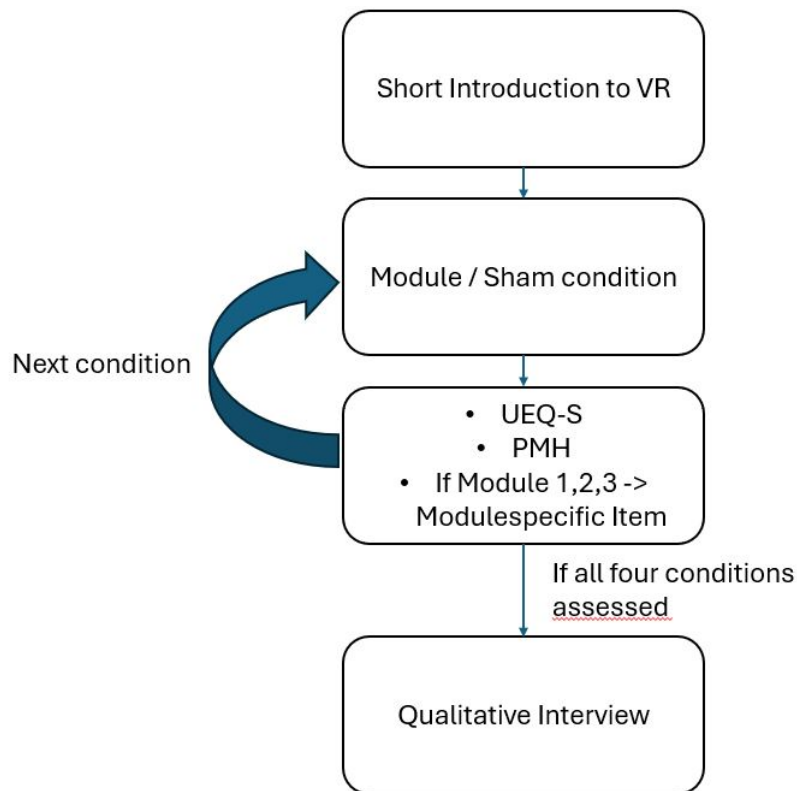


Fig. 2 Interview Session Flowchart

[Technologies 2026](#)) combined with Meta XR All-in-One Version 77.0 ([Meta Platforms, Inc. 2025](#)) for development.

The final version of the VR application is planned to consist of nine modules. The showcased application contains three different modules of the final version. The three modules were used for assessment because they cover the key areas of resilience, introspection, and social and emotional skills of the planned full study. Exemplary screenshots of the three modules are shown in Figure 3.



Fig. 3 Exemplary screenshots of the three showcased modules (left to right: Module 1, Module 2, Module 3)

Due to the scarcity of existing VR therapy applications and the strong focus on interpersonal interaction in existing therapy manuals, the content of the three modules was adapted from evidence-based intervention programs and therapy manuals for adolescents that primarily focus on the treatment of anxiety and depression [Güroff \(2018\)](#), [Hautzinger \(2013\)](#) and [Berking \(2017\)](#). In addition, we conducted a brief literature search for "Virtual Reality" AND ("Depression" OR "Anxiety") on PubMed and combined the results with exercises from the therapy manuals. Based on these sources, we evaluated the existing applications and therapy exercises and designed modules in cooperation with two licensed psychotherapists.

The first module presents a classroom scenario in which the user embodies a student. A virtual teacher calls on the student to come to the blackboard to solve a problem. After answering the question, regardless of whether the answer is correct, the user hears laughter. Afterward, the potential negative thoughts will be investigated and resolved using either Acceptance and Commitment Therapy (ACT) or cognitive restructuring. The exact method depends on which of the presented alternative thoughts the user chooses and considers more useful in such a situation. This module should help build social skills and resilience because social situations such as presentations, where the presenter fears making mistakes, being laughed at, or being criticized for their work, are often included in therapy manuals for building social skills ([Güroff 2018](#)). To reevaluate social situations, such as other laughing classmates, is also part of depression manuals for adolescents ([Hautzinger 2013](#)). Therefore, this module combines a potentially inconvenient situation (the presentation) in a common place for adolescents (classroom) to train important methods for dealing with potential negative thoughts by leveraging ACT and cognitive restructuring.

For the second module, guided imagery combined with breathwork was utilized to reduce stress and anxiety. Breathwork was chosen as an exercise because studies provided evidence that it could reduce negative emotions, including anxiety and stress ([Balban et al. 2023](#); [Fincham et al. 2023](#)). The standardized 4-7-8 breathing technique was used as an exercise because research shows it can effectively reduce anxiety and stress across multiple health conditions. ([Pandekar and Thangavelu 2019](#); [Aktaş and İlgin 2023](#); [Abdelfatah et al. 2024](#)). This breathwork technique was incorporated into a guided imagery exercise because it has been shown to positively affect various mental health disorders ([Trakhtenberg 2008](#); [Gruzelier 2002](#)). [Apóstolo and Kolcaba \(2009\)](#) showed that guided imagery can successfully reduce anxiety and stress of psychiatric inpatients with depressive disorders. The guided imagery consists of a walk through a forest, accompanied by relaxing music, combined with the 4-7-8 breathwork exercise to ensure the module can be used repeatedly in various stressful situations.

The third module implements an exercise to visualize negative emotions, thoughts, and self-beliefs, and then helps relieve them. This exercise combines visualizing thoughts as clouds ([Lindner et al. 2019](#)) with releasing them through imagination ([Wagener et al. 2023](#)). The user stands in a green meadow with flowers, and their task is to write down negative thoughts and self-beliefs on clouds and send them into the sky to relieve them.

2.6 Sham Condition

The Meta Quest application "First Steps" served as a sham condition and was used to account for nonspecific factors such as distraction, expectancy effects, goal attainment, and exposure to VR technology, without including depression-specific intervention elements (Meta (Oculus) 2019).

"First Steps" is a game that demonstrates the VR headset's different interactive options. This includes explaining how to use the VR headset controller and how to use the hand as a controller. It also lets users explore different objects, such as building with blocks, playing table tennis, and throwing a paper airplane. Importantly, the game does not contain any psychological content. It serves for three purposes: 1. have a VR application with no psychological content to assess the difference to the three developed modules on a psychological scale, 2. give the participants a good reference of what could be possible with VR, so that they could give better input in the qualitative interview and 3. have a reference for user experience to check if our developed modules achieve a similar user experience as the professionally developed demonstration game.

2.7 Data analyses

R was used for calculating descriptive and inferential statistics (R Core Team 2025). The mean and standard deviation for all suitable variables were calculated (age, feasibility, participant appreciation, UEQ-S, module goal items). In total, we had three missing values. Therefore, we calculated Little's Missing Completely at Random (MCAR) test (Little 1988). The test was not statistically significant $\chi^2(32) = 37.4$, $p = .24$. Thus, the assumption that the data were MCAR was retained. Additionally, ANOVAs and pairwise t-tests were conducted using the PMH-Scale, UEQ-S, and the three items related to the module's primary goals.

To analyze the qualitative data (semi-structured interviews) in the form of open-ended questions, we first recorded and transcribed the interviews. Given the five existing categories and the deductive approach derived from the literature (see Section 2.4.5), we conducted a qualitative content analysis based on Mayring and Fenzl (2019). As categories for this, we used the five derived categories. Two independent coders categorized, coded, summarized, and analyzed the interview answers. For presenting the results, n and the corresponding percentage refer to how many participants mentioned something, not the number of mentions.

3 Results

3.1 Application Design

3.1.1 Atmosphere and Connection to Nature

55% of participants ($n = 11$) favored virtual natural environments in general. For relaxation, 95% of participants ($n = 19$) strongly favored virtual natural environments, especially meadows and forests. The multisensory elements received positive feedback as well: Several participants ($n = 9$; 45%) emphasized that they enhanced immersion and promoted relaxation.

A few participants ($n = 6$; 30%) criticized the "playful" visual arts and would prefer a more "realistic" visual presentation. The participants suggested increasing the intensity of the situation to elicit stronger emotional responses.

The therapists considered natural environments beneficial for relaxation, as it was used in the second module. Otherwise, they preferred a realistic setting to carry out therapeutic interventions, such as exposure therapy. All therapists and a few participants ($n = 6$; 30%) noted that a certain degree of flexibility in room design and room selection is therefore important to accommodate different needs.

3.1.2 User-Centered Design

A few participants ($n = 3$; 15%) expressed a desire for a greater variety of individual thoughts and the option to enter their own thoughts. In addition, a 35% of participants ($n = 7$) suggested including a larger number of situations and situations of longer duration. To further ensure a realistic therapeutic setting, some participants also emphasized the need for flexibility ($n = 6$; 30%) and individualization ($n = 1$; 5%). As mentioned above, this seems important to address patients' needs and the various requirements of therapy. Many participants ($n = 11$; 55%) considered an introduction to using the VR headset and instructions before the modules to be essential. But some criticized the hardware ($n = 4$; 20%): the headset was too heavy, uncomfortable, and not adjustable for children.

The therapists considered VR use more difficult for them than for the children and adolescents. They would like the VR to be easy to use on their own, the VR headset to be durable and comfortable, and the usage to be limitable: *"So, to make sure it doesn't overwhelm them or cause retraumatization. [...] Or they might just browse through all the rooms, and in the process, they'll get used to it without any therapeutic effect. Then the effect is limited because I'm not paying attention to my physical reactions or thoughts."* - therapist 1

3.1.3 Interaction and Learning

The interactive elements of the modules were positively reviewed by most participants ($n = 15$; 75%), who felt they would enhance the VR experience by making it livelier and more motivating.

The explanation should be better adapted for children and adolescents, which was mentioned by participants ($n = 2$; 10%) and therapists ($n = 2$; 66.7%). Because of the age of the target group, the explanations were perceived as too complex and could be shortened.

Some participants ($n = 3$; 15%) and all three therapists rated the breathwork exercise as too long. One therapist suggested a 3-5-6 exercise instead of the implemented 4-7-8 to account for probably lower lung volumes.

For future implementations of the VR modules in a therapeutic setting, several participants ($n = 7$; 35%) and all therapists demanded more repetitions, different exercise scenarios, or the incorporation of the exercises into a therapeutic intervention.

Learning could be enhanced through more interactive explanatory elements, such as videos and an explanation before the situation starts. A few participants ($n = 2$; 10%) recommended that the situation should be discussed afterward and that the

therapist could see what the patient sees in the VR or could even manipulate objects in the VR: *“Well, it would be good if the therapist could also see what I see. The classic setup, with a screen next to me, so that I’m not completely alone in this process. [...] If the therapist can’t see at all what you’re seeing, then it’s much harder for them to respond appropriately.”* – participant 1

The therapists considered the following interactive elements to be helpful: Role-Play with models who resemble the subject or using avatars to support the patient in the VR and foster the therapeutic relationship. Interactive elements could also help with relaxation exercises for patients who find it difficult to use imaginative techniques or to focus on psychoeducation.

3.1.4 Accessibility

35% of participants ($n = 7$) reported difficulties with navigation, particularly regarding the hand movements required to select desired items. The formatting of the text was perceived to be too large by a few participants ($n = 3$; 15%), which negatively affected readability. Too many visual or acoustic stimuli and technical issues led to potential distractions, as well as hardware problems or uncertainties about usage, which was mentioned by several participants ($n = 7$; 35%).

40% of participants ($n = 8$) could imagine using the intervention on their own (, while others would prefer to be guided by a therapist ($n = 4$; 20%), especially when it comes to more challenging interventions: *“Well, I think at the beginning it’s definitely important to do this together first. Maybe even in a safe space, so that you can get help and guidance if anything comes up. And I think that once this has been practiced together in therapy a few times, doing it at home becomes easier, because by then it’s part of your routine and you already know what to do.”* – participant 8

The therapists, however, were skeptical about independent use and pointed out that it is important to monitor patients’ reactions. They had ideas for using the VR headset only in a therapeutic setting and for practicing homework at home without it, involving parents as co-therapists or offering additional appointments dedicated solely to VR.

3.1.5 Information and Data Privacy

Privacy seems to be important to many people, but it is not their top priority ($n = 9$; 45%). They explained it by saying that they had no idea what their data was used for or that they did not care. Nevertheless, other participants expressed the desire for their data to be handled transparently and to receive clarification regarding data protection ($n = 7$; 35%).

The therapists pointed out that children are often unaware of privacy risks. Therefore, patients and their parents must be educated about it: *“I believe that children are sometimes unaware of the risks posed by data protection gaps. But I think it’s extremely important to educate them about this and to make sure they are aware of it.”* – therapist 2

3.2 Evaluation

3.2.1 User Experience and appreciation

All three assessed modules have a good user experience. The UEQ-S ranged from 5.86 to 6.47 out of 7, see Table 4. A repeated measures ANOVA was conducted to investigate differences in UEQ-S scores across the modules. The results of the Mauchly's test indicated that the assumption of sphericity was violated, $W = .20$, $p < .001$. Therefore, Greenhouse-Geisser corrected degrees of freedom are reported. There was a significant main effect of time on the UEQ-S scores, $F(1.53, 29.01) = 5.11$, $p = .019$. The effect size was $\eta_p^2 = .13$, indicating a medium to large effect. Post-hoc comparisons with Bonferroni correction revealed no significant differences between point of measurements (all $p > .05$).

The qualitative part of the interviews revealed that the first and second modules were evaluated as offering a very good user experience. However, while the third module also has a high UEQ-S score, it was rated ambivalent both in the quantitative part, see Figure 4, and in the qualitative interview part. The participants liked the approach and the virtual world in general, but had some difficulties with writing in VR. Therefore, in terms of user experience, they liked it the least among the modules presented.

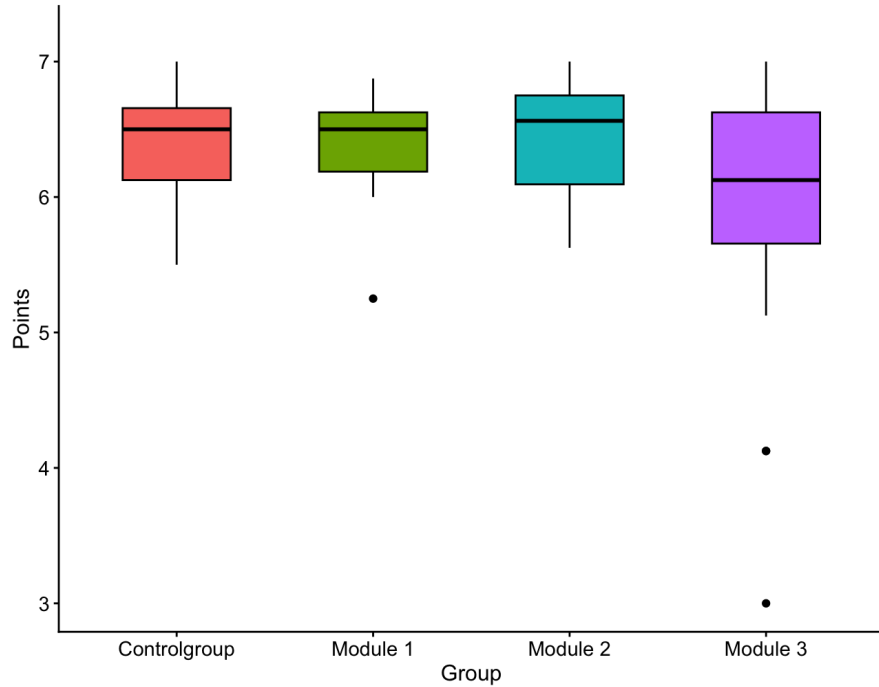


Fig. 4 Comparison of User Experience Across Modules

3.2.2 Positive Mental Health Scale

In terms of the PMH-Scale while the pre-assessment was at 2.28 the range of the post-assessment was 2.33 to 2.41, see Table 4.

A repeated measures ANOVA was conducted to investigate differences in PMH scores across the five points of measurement. A significant difference and effect through calculating ANOVA could not be found. There was a significant main effect of time on the PMH scores, $F(4, 76) = 3.31$, $p = .015$. But the effect size was very small $\eta_p^2 = .008$, and post-hoc comparisons with Bonferroni correction revealed no significant differences between point of measurements (all $p > .05$).

Table 4 UEQ-S and PMH-Scale descriptive statistics (mean and standard deviation).

Scale	Condition / Time	M	SD
UEQ-S	Control group	6.41	0.45
UEQ-S	Module 1	6.37	0.39
UEQ-S	Module 2	6.47	0.44
UEQ-S	Module 3	5.86	1.04
PMH	Pre-Assessment	2.28	0.48
PMH	Control group	2.41	0.48
PMH	Module 1	2.33	0.47
PMH	Module 2	2.40	0.54
PMH	Module 3	2.33	0.55

3.2.3 Anxiety, Stress, Negative Thoughts

The first module, school anxiety, was evaluated quite well ($M = 5.2$, $SD = 1.15$). Many participants ($n = 8$; 40%) appreciated its implementation. Others ($n = 2$; 10%) could not relate to it, because they thought it was not immersive enough.

The second module, with the breath exercise, was evaluated most positively ($M = 5.7$, $SD = 0.57$). Many participants ($n = 15$; 75%) reported that the modules helped them relax or explicitly stated that it was the best module.

The third module, on negative thoughts, was evaluated the worst ($M = 4.7$, $SD = 1.08$). Most participants ($n = 16$; 80%) had difficulty writing in VR, and some ($n = 2$; 10%) could not relate to it and reported feeling overwhelmed and a bit lost about what to write on the clouds.

4 Discussion

This pilot mixed-methods RCT evaluated the feasibility, user acceptance, and user experience of a prototype VR depression and anxiety therapy application for adolescents and young adults. As a secondary objective, we conducted a literature-based requirements analysis and evaluated them with adolescents and young adults ($n=20$) and therapists ($n=3$). Overall, the user experience and acceptance of the designed

interaction were high. While no significant effect could be found on positive mental health, participants reported a reduction of negative thoughts, school-related anxiety, and stress. The application can be evaluated as feasible. While VR has been extensively studied for exposure therapy in adults and for other mental health conditions in adolescents, to our knowledge, no RCT has examined VR interventions particularly designed for depression in adolescents. Our study addresses this critical gap by focusing on the design and feasibility of an application targeted at adolescents, using a participatory approach involving both therapists and adolescents/young adults.

Our results show high ratings on user experience and user acceptance for the present VR application, especially regarding factors like engagement and fun. In particular, the two modules with low to moderate interactivity (i.e., the first and second modules) were generally assessed positively. The module with the highest interaction option (the third module) was assessed as having the poorest but still good user experience, both qualitatively and quantitatively using UEQ-S. Surprisingly, contrary to predictions, the Control Group received the highest user experience rating. One possible explanation could be that the application we used as a reference was a showcase from the VR headset manufacturer of the possibilities of VR applications. Subsequently, the data indicate that Modules 1 and 2 provided a user experience comparable to the professional tech demo. This is especially interesting because Module 1 covered a negative situation, whereas the Techdemo covered only positive activities. Even though the participants had potentially negative feelings, the user experience was still evaluated on par with the Techdemo. Module 3, in general, also offered a good user experience for some participants, but the range was very high. The reason for this was revealed in the qualitative interviews. The interaction with the virtual pen was perceived as very difficult. This needs to be reworked in the final application and considered for future similar applications.

Regarding future requirements of the final RCT study all new requirements were elicited based on the feedback of the participants. In terms of "Atmosphere and Connection to nature", additional modules will be designed with virtual natural environments. Previous studies have shown that delayed or conflicting signals in VR can trigger a sensory conflict that causes motion sickness ([Chang et al. 2020](#); [Rowland et al. 2025](#)). This discrepancy in signals can be intensified by technical problems, which can increase motion sickness ([Chang et al. 2020](#)). Hence, future studies will consider this by replacing some playful arts with realistic arts only where possible to improve performance, because more realistic arts can also result in a worse (technical) performance. To strengthen the "user-centered design", the final study will offer clearer guidance and add modules that enable users to visualize and actively work with their thoughts. Regarding "Interaction and Learning", we will make minimal revisions, adding more visual explanations and adjusting text for readability. For "accessibility", we will make minor adjustments to the final study, including text formatting and additional instructions. Regarding the "Information and Data policy", the current application appears to be sufficient. The application did not rely on a server connection; the avatar used is a standard avatar, unrelated to the individual's avatar created in the Meta Quest headset.

Regarding efficacy, we found no significant effect on the PMH. However, participants reported reductions in stress, school-related anxiety, and negative thoughts on our self-developed items and confirmed these reductions in the interviews. This discrepancy may be attributed to the short intervention time (about 30 minutes). VR studies with significant effects often target only one specific skill, such as [Guldager et al. \(2022\)](#) targeting drinking and drug refusal self-efficacy, but with a longer session (45 minutes). Alternatively, if a reduction of symptoms of a mental health condition is attempted, studies involve multiple sessions over multiple weeks, such as [Kahlon et al. \(2024\)](#); [Wong et al. \(2024\)](#), which showed that social skills are improved through 12-15 sessions over 6 to 12 weeks. Another explanation could be that the PMH score was already quite high in the pre-assessment (2.28 of 3). While research indicated that higher interactivity leads to a higher reduction of symptoms ([Massanneck et al. 2026](#)) this effect could not be found. The third module was assessed as the weakest in reducing symptoms. Five categories of requirements for the application design were derived from literature: "Atmosphere and connection to nature", "User-Centered Design", "Interaction and Learning", "Accessibility", and "Information and Data privacy". The interviews indicate that for adolescents the most important categories were "Atmosphere and connection to nature", "Interaction and Learning", "User-centered Design" and "Accessibility" while "Information and Data Privacy" was not assessed as relevant. This largely aligns with current Design-Science-Research, as [Turan Akdag et al. \(2023\)](#) and [Massanneck et al. \(2024\)](#) derived design principles for remote VR psychotherapy applications in which a therapist conducts a session with an adult patient. The derived categories overlap with the design principles by [Turan Akdag et al. \(2023\)](#) and [Massanneck et al. \(2024\)](#), such as "Motivation and engagement", "technical guidance", "Principle of Usability", and "Principle of Interactivity". The results seem generally transferable from adults to adolescents, while for adults, the category "Information and Data Privacy" appears far more relevant.

The major strength of this study is that it demonstrates that designing a VR application with high user experience and acceptance, and conducting an intervention are feasible for treating adolescents. By offering an engaging, immersive application, the study could achieve a user experience on par with a professionally developed showcase application. Another strength is that the participative approach and the interview component revealed that highly interactive modules can make the application difficult to use and, therefore, frustrating. These difficulties and frustrations may also explain the lowest perceived reduction in negative symptoms.

This study has some limitations. First, the majority of participants (19 of 20) fall within the young adult bracket, resulting in a mean age of 18.95. Therefore, results may not be transferable to younger adolescents. Second, 80% of the participants were female. This could limit the received feedback to potential gender-specific issues of the application. Relatedly, some participants with a background in psychology may have identified their respective condition (sham condition or intervention). On the other hand, the high number of psychology students has provided strong suggestions for further development of the application. Third, we could not find significant results for the PMH-Scale, possibly due to the very short time frame during which participants

used the applications (approx. 30 minutes total). While in qualitative research questions are normally as open as possible, our questions are narrower due to the literature review conducted, which poses another limitation. Another limitation is that we had a relatively small sample size with a potentially healthy population. Therefore it is possible that smaller effects could not be found.

This study offers many implications for research and clinical practice. First, it emphasizes the need for low-threshold engaging remote and blended psychotherapy applications for adolescents. Second, it demonstrates that engaging and immersive remote VR applications could be an option for offering adolescents a psychotherapy intervention with low use of therapy resources. Third, this study demonstrates how a VR application for adolescents and young adults should be designed and which factors are important for them. Fourth, our study shows that the VR intervention may be successfully integrated into clinical practice.

Future research should include clinical samples and a broader age range of children and adolescents to improve the generalizability of findings. Longitudinal studies with a larger sample size are needed to evaluate the long-term effects of VR interventions on positive mental health and other relevant outcomes. Further research should also investigate how VR can be effectively integrated into routine mental health care, for example, as an adjunct to psychotherapy or to bridge waiting times, while establishing its efficacy and identifying when independent use is appropriate versus when therapist guidance is required. Finally, advances in VR technology, including lighter headsets, improved tracking, and strategies to reduce cybersickness, may further enhance the clinical applicability and feasibility.

The study’s results are particularly interesting for future research. Indicating that high interactivity is not necessary for an effective VR intervention, although adolescents report that interactivity is highly important and appealing, positive effects on mental health are found even with low interactivity (Massanneck et al. 2026). It could be reasoned that VR is, for most participants, even for digital natives, a new and relatively unknown technology. Until VR is established in the mainstream, it could be better to offer a simple, moderate interactive application so that all participants could use it without frustration. This concept should be investigated in the future.

5 Conclusion

This study helps to reduce the lack of literature on how to design a VR psychotherapy application for adolescents. In contrast to many VR interventions, which focus on other mental health conditions and have only been developed and tested in clinical trials, this paper contributes to the literature on which parts of a VR application are crucial for psychotherapy. We used a participatory approach to co-create a high-fidelity VR therapy application. The participants’ feedback will be used as participatory input for further revisions of the final VR application. A RCT will be conducted to investigate the effects of the application over a longer time frame.

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Authors' contributions

Steffen Massanneck: Designing and programming the VR prototype. Mainly responsible for writing the first paper draft. Planning the Study Design. Data Analysis. Preparing the manuscript for submission. **Johanna Sader:** Writing the first paper draft. Conducting interviews. Data Analysis. **Anja Pascher:** Feedback on module content and first paper draft. **Lennart Seizer:** Feedback on study design and first paper draft. **Lena Kubitschek:** Assisting with writing and formatting the original draft. Data Analysis. **Matthias Berking:** Reviewing the original draft. **Fanny Dietel:** Feedback on research design, reviewing the original draft. **Johanna Löchner:** Conceptual help on the research design, reviewing the original draft.

Availability of data and materials

Supplementary files (Videos of the modules and research data) can be found at https://osf.io/7cu2m/overview?view_only=48b6b7e714934146803ae630b27542a5

Statements and Declarations

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Competing interests

The authors declare that they have no competing interests that could have influence the work presented in this paper.

Ethics approval and consent to participate

All participants provided written consent for conducting and publishing the results of the interviews. For participants under 18 years, the parents also provided written consent. The study was conducted in compliance with the Declaration of Helsinki. This study served as a pilot for a subsequent study (RISE-VR), which the Ethics Committee of the Medical Faculty of LMU Munich approved.

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