

Differential efficacy of imagery, virtual reality and 360° video exposure therapy in reducing test anxiety in university students: A pilot study

Itziar Quevedo-Bayona^a, María-Camino Escolar-Llamazares^{a,*}, María Ángeles Martínez-Martín^b

^a Department of Health Sciences, University of Burgos, Spain

^b Department of Educational Sciences, University of Burgos, Spain

ARTICLE INFO

Keywords:

Test anxiety
Exposure therapy
Virtual reality
360° videos
Imagination
University students

ABSTRACT

Introduction: Since test anxiety is a phenomenon that affects many students both academically and personally, this study presents an innovative exposure intervention based on 360° videos.

Objectives: To reduce test anxiety among university students participating in a test anxiety management intervention program, to evaluate exposure therapy using 360° videos compared to other exposure therapies, and to assess participants satisfaction.

Method: An applied experimental pre-post study was conducted using an inter-intra A-B design. Twenty university students participated in the study. Ten of them were randomly assigned to one of three experimental conditions; exposure with 360° videos (360), virtual reality (VR), and imagination (IM); while the remaining ten students constituted the control group. Four questionnaires were used as assessment tools to measure general state and trait anxiety (STAI), as well as state (CRAP) and trait (IAE) test anxiety. A satisfaction questionnaire was also administered.

Results: A tendency of reduction in both general anxiety and test anxiety was observed in all participants. No significant differences were found between the three experimental conditions. All students reported high satisfaction scores with the intervention.

Conclusions: Exposure through the three modalities appears to be both effective and well-accepted among students.

1. Introduction

Test anxiety is a phenomenon of great relevance in the university context, as it affects both students' academic performance and their emotional well-being. Previous research has shown that this type of anxiety manifests in motor, physiological-affective, and cognitive responses that interact with one another, significantly influencing academic experience (Lang, 1968).

In this sense, test anxiety is understood as a specific form of anxiety linked to educational situations in which individuals are, or perceive themselves to be, evaluated (Escolar-Llamazares et al., 2023; Serrano Pintado & Escolar Llamazares, 2015). Its negative consequences not only hinder performance in exams and tests but also impact students' overall psychological health (Escolar Llamazares & Serrano Pintado, 2014).

Therefore, it is necessary to design and implement intervention programs aimed at managing this type of anxiety and to develop

therapeutic methods specifically supported by efficacy studies (Serrano Pintado et al., 2016; Von der Embse et al., 2013; Zeidner, 2007).

Within this framework, scientific literature highlights the importance of implementing interventions grounded in solid theoretical models and evidence-based psychotherapeutic strategies capable of addressing the different components of anxiety (Anyamene & Udeagha, 2025).

Among these, test anxiety management programs, particularly those developed within the cognitive-behavioral paradigm, have shown strong effectiveness by providing students with tools to reduce anxiety symptoms, foster academic resilience, and improve adaptive coping (Nwadi et al., 2025). Furthermore, the integration of new technologies in mental health therapies offers innovative opportunities to enrich exposure techniques and enhance the accessibility of these programs within higher education (Doğan et al., 2025).

* Corresponding author.

E-mail addresses: [iquevedo@ubu.es](mailto:iQuevedo@ubu.es) (I. Quevedo-Bayona), cescolar@ubu.es (M.-C. Escolar-Llamazares), amart@ubu.es (M.Á. Martínez-Martín).

<https://doi.org/10.1016/j.actpsy.2025.105829>

Received 6 March 2025; Received in revised form 15 October 2025; Accepted 20 October 2025

Available online 29 October 2025

0001-6918/© 2025 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC license (<http://creativecommons.org/licenses/by-nc/4.0/>).

1.1. Theoretical framework

The present study is grounded in complementary theoretical perspectives that together provide the conceptual basis for understanding and intervening in test anxiety. From the classical and contemporary conceptualizations of anxiety, test anxiety is defined within the framework of general anxiety theory, particularly following Spielberger's distinction between state and trait anxiety (Spielberger et al., 1970).

This differentiation between these two forms of anxiety has been fundamental for both research and applied interventions (Guo & Liao, 2025). State anxiety, being situational and fluctuating, provides an explanation for the intense nervousness students may experience specifically before and during examinations, even when they do not generally report high anxiety in other contexts (Anyamene & Udeagha, 2025).

On the other hand, trait anxiety highlights the role of personality and individual predispositions, helping to understand why some students are consistently more vulnerable to experiencing evaluative stress. This dual approach allows researchers and practitioners to design interventions that not only target situational stress management but also promote long-term coping strategies that mitigate dispositional tendencies (Mur et al., 2022).

Historically, research on test anxiety has its roots in the broader study of performance under stress. Early investigations in the 1950s and 1960s began to differentiate between the cognitive and emotional components of anxiety, highlighting that anxiety was not only a matter of physiological arousal but also a mental preoccupation with fear of failure (Liebert & Morris, 1967; Sarason, 1960).

These early studies laid the groundwork for later multidimensional models that conceptualized test anxiety as a construct involving cognitive worry, emotionality, and behavioral responses. The classic contributions of Mandler and Sarason, for instance, emphasized how worry could interfere with students' ability to recall information during an exam, a notion that continues to influence modern perspectives (Sarason & Mandler, 1952).

In addition to Spielberger's model (Spielberger et al., 1970a), other theoretical perspectives have contributed to broadening the conceptualization of test anxiety. Cognitive theories emphasize the role of negative automatic thoughts, worries about failure, and self-deprecating internal dialogues that often accompany evaluative situations (Dundas & Nygård, 2024).

These cognitions not only intensify the emotional experience of anxiety but also interfere with working memory and attentional resources, further compromising performance (Xu & Wei, 2024). Physiological models, meanwhile, underscores the activation of the autonomic nervous system, pointing to symptoms such as tachycardia, sweating, and gastrointestinal discomfort as common correlates of anxiety (Huang et al., 2023).

From a behavioral standpoint, avoidance becomes a frequent maladaptive response, as students may procrastinate or even withdraw from evaluative situations in order to reduce immediate distress, inadvertently reinforcing the maintenance of anxiety in the long term (Albulescu et al., 2024).

This theoretical richness has fueled the design of intervention programs for test anxiety, which have been extensively developed, providing students with adaptive strategies to face the situation and thus prevent avoidance, as well as minimizing significant reductions in academic performance. These interventions range from relaxation training and study skills workshops to more complex integrative programs that combine multiple therapeutic components (Nwadi et al., 2025).

Among these programs, those framed within the cognitive-behavioral paradigm appear to be the most effective, as they target maladaptive thought patterns and conditioned responses that maintain anxiety. Cognitive-behavioral approaches are based on the premise that by modifying distorted cognitions and maladaptive behaviors, emotional responses can also be transformed (Doğan et al., 2025; Eya

et al., 2024).

Thus, these programs not only aim to reduce anxiety symptoms but also to promote academic resilience, self-efficacy, and adaptive coping mechanisms. This study is based on a specific cognitive-behavioral intervention for university students described by Serrano Pintado and Escobar Llamazares (2015).

This program is grounded in Stress Inoculation Training (SIT) (Meichenbaum & Cameron, 1972, cited in Muñoz & Pérez, 1997), as a structured approach designed to "inoculate" students against test anxiety by gradually exposing them to manageable evaluative stressors. The underlying principle is that resistance to stress can be increased by confronting stimuli strong enough to activate coping mechanisms without overwhelming the individual (Serrano Pintado & Escobar Llamazares, 2015). This stress inoculation program consists of three phases: educational, practice, and application (Escobar-Llamazares & Serrano-Pintado, 2014).

The educational phase focuses on increasing students' awareness of the mechanisms underlying anxiety, including physiological arousal, cognitive avoidance (Naseri & Marashian, 2025). By understanding these processes, students are better prepared to engage with the subsequent stages of training. The practice phase introduces specific coping techniques, such as relaxation strategies, cognitive restructuring, and problem-solving skills, allowing students to develop a repertoire of adaptive responses (Finseth et al., 2025).

Finally, the application phase emphasizes the importance of transferring these skills to real evaluative contexts, where students are exposed to anxiety-inducing situations under controlled conditions. In this application phase, exposure tools are implemented to allow students to face different anxiety-inducing situations (Finseth et al., 2025).

Exposure therapy involves gradual exposure to the source of anxiety, in this case to exams or exam-related environments. This type of intervention is not limited to symptom reduction; it also fosters learning processes such as habituation and cognitive reappraisal, where students progressively reinterpret evaluative situations as less threatening (Eya et al., 2024).

In addition, exposure therapy helps reduce both the physiological responses associated with anxiety, such as accelerating heart rate or excessive sweating, as well as cognitive responses such as intrusive thoughts and worries (Serafini & Chittaro, 2025).

Exposure therapy can take multiple forms. Live exposure involves confronting feared situations in real life in a gradual and controlled manner, while imaginal exposure requires students to visualize feared scenarios in a safe and relaxed state using their imagination. More recently, virtual exposure approaches using the VR environments have shown effectiveness in reducing test anxiety, improving academic performance, and increasing positive engagement with the intervention, although cost remains a limitation (Serafini & Chittaro, 2025).

As a more accessible alternative, 360° videos provide immersive experiences that replicate familiar academic environments, allowing students to practice coping strategies in a realistic but controlled setting. Preliminary evidence suggests that 360° videos can significantly reduce test anxiety symptoms, offering a promising low-cost option for exposure-based interventions (Doğan et al., 2025).

From a contemporary perspective, the relevance of studying test anxiety in higher education is undeniable. University students face a wide range of stressors, including high academic demands, uncertainty about the future, and the need to balance studies with work or personal responsibilities (Escobar Llamazares et al., 2023; Yessimbekova et al., 2025).

In this context, test anxiety becomes not only a barrier to academic achievement but also a factor that undermines psychological well-being. The growing interest in mental health within universities highlights the need for evidence-based interventions that are both effective and accessible (Tan et al., 2025). Programs that integrate technological tools, such as virtual or 360° exposure, respond to this demand by combining scientific rigor with innovative formats that appeal to new

generations of students (Doğan et al., 2024, 2025).

1.2. Objectives of the study

In this context, the purpose of the present research has been to test three types of exposure: 360° videos (360), Virtual Reality (VR), and Imagination (IM), implemented within a stress inoculation-based training program to reduce test anxiety in students at the University of Burgos (Burgos, Spain). This training program was offered as part of the group intervention options provided by the University of Burgos Health Care Service (SUAS-UBU).

Specifically, the objectives have been to explore:

1. Whether the Test Anxiety Management Program with the different types of exposure implemented (360, VR, and IM) reduces test anxiety levels.
2. If such a reduction occurs, whether it is to the same extent with any of the three types of exposure used.
3. Whether participant satisfaction with the exposure varies depending on the type of exposure assigned.

2. Methods

2.1. Design

To test the objectives, a pilot applied quasi-experimental pre-post study was conducted with three independent groups corresponding to the three exposure training conditions: (360) = 360° Videos; (VR) = Virtual Reality; and (IM) = Imagination (Campbell & Stanley, 2005). Specifically, an A-B mixed design (inter- and intra-subject) was applied. In addition, a retrospective active control group was included, which participated in an alternative intervention focused on learning study techniques rather than exposure-based anxiety management.

The active control group was chosen because it allows the researchers to distinguish the specific effect of the exposure-based intervention from the general effects of receiving any kind of support or training. If the comparison had only been made with a no-intervention group, it would not be clear whether improvements were due to the actual content of the program or simply taking part in a structured intervention, receiving professional attention or acquiring new skills. It is important to note that the baseline anxiety levels of the retrospective active control group and the experimental group are not directly comparable, since participants in the control group exhibited lower initial levels of anxiety. Therefore, the results should be interpreted with caution.

The main independent variable (between-subjects) was the type of exposure used, with three levels (360, VR, and IM). The within-subjects independent variable was the measurement taken before the intervention (pre-treatment or pre) and after the intervention (post-treatment or post). The dependent variable was the level of anxiety response, operationalized as the level of anxiety reported by students through various questionnaires. Additionally, participant satisfaction with the exposure therapy was assessed at the end of the intervention.

2.2. Participants

The sample consisted of 20 university students, including 10 participants in the Test Anxiety Management Program (experimental group) (1 male and 9 female) and 10 participants in the Study Techniques Program (active control group) (1 male and 9 female), all of whom volunteered to participate in interventions offered by the University of Burgos Health Care Service (SUAS-UBU). The average age of participants was 22.15 years ($SD = 5.40$), with the youngest being 19 years old and the oldest 43.

The participants came from various academic fields: 8 students (40 %) from Engineering and Architecture, 3 students (15 %) from Health

Sciences, 6 students (30 %) from Political Sciences and Law, 2 students (10 %) from Sciences and 1 student (5 %) from Humanities and Communication.

In terms of academic year: 9 students (45 %) were in their second year, 7 students (35 %) were in their third year, and 4 students (20 %) were in their first year.

The 10 students participating in the experimental group were randomly assigned to one of the three experimental conditions: 4 students in the 360 group (exposure with 360°), 3 students in the VR group (exposure with Virtual Reality) and 3 students in the IM group (exposure with Imagination). The control group students all participated in the same program: Study Techniques Program, which will be explained further in the manuscript (see Table 1).

2.3. Instruments

2.3.1. Evaluation instruments

The following scales and questionnaires were used:

To measure General Anxiety:

The *State-Trait Anxiety Inventory* (STAI) (Spielberger et al., 1970; Spielberger et al., 2015). This is a 40-item self-report inventory that measures situational anxiety (State Anxiety) and general trait anxiety (Trait Anxiety) both cognitively and physiologically (level of worry and emotional activation). These two subscales consist of 20 items each, scored on a 4-point Likert scale: 0 = not at all, 1 = a little, 2 = quite a bit, 3 = very much. This inventory was designed for both individual and group administration. In Spanish population samples, it shows high internal consistency (between 0.90 and 0.93 for STAI-E and between 0.84 and 0.87 for STAI-R) and high correlations with Cattell's Anxiety Scale (between 0.73 and 0.85). The test manual does not indicate the specific percentile at which anxiety is considered high, so the standard of Martínez-Otero (2014) was followed, which defines high anxiety as those above the 75th percentile (Medina-Gómez et al., 2019).

To measure Test Anxiety:

The Test Anxiety Inventory (TAI) (Spielberger, 1980) measures trait anxiety in response to exams, focusing on both physiological and cognitive manifestations (Serrano Pintado et al., 2002). The original version of this inventory shows high reliability, with a Cronbach's Alpha coefficient of 0.92 (Escobar-Llamazares & Serrano-Pintado, 2019).

The Inventory of Test Anxiety (ITA; (Osterhouse, 1969) measures state anxiety in response to exams, focusing on the physiological and cognitive experiences a person has after taking a test or exam. It consists

Table 1
Characteristics of the participants.

	360° videos	RV	Imagination	Control group	Total Sample
Number of participants	N = 4	N = 3	N = 3	N = 10	N = 20
Males	1	–	–	1	2
Females	3	3	3	9	18
Average age	23.25	29.33	21	19.9	22.15
Standard Deviation	2.63	12.09	1.73	1.52	5.40
Humanities and Communication Students	–	1	–	–	1
Engineering and Architecture Students	2	1	2	3	8
Health Sciences Students	1	1	–	1	3
Political Sciences and Law Students	1	–	1	4	6
Sciences Students	–	–	–	2	2

of 16 items, each addressing a specific symptom or experience related to anxiety during an exam, such as feeling panic, worrying about not finishing the test, dry mouth, or negative thoughts about one's performance. Osterhouse developed it specifically to measure the effects of treatments aimed at reducing exam anxiety. Its reliability, calculated using the split-half method, was found to be 0.92 (McMillan & Osterhouse, 1972; Osterhouse, 1972).

To measure the satisfaction with the exposure therapy:

Satisfaction with the exposure therapy experience questionnaire. This questionnaire was designed ad hoc based on the Treatment Satisfaction Scale (CRES-4) (Feixas i Viaplana et al., 2012). The scale measures the satisfaction and acceptability of the patient with the experience of exposure to anxiety-inducing situations. The questionnaire consists of 10 questions that are answered on a Likert scale from 1 to 10, where: 1 = Not satisfied at all and 10 = Completely satisfied. The questions focus on the perceived appropriateness of the situations faced, the support provided by the therapist, the quality and intensity of the scenes faced, the sense of control during the exposure and the overall effectiveness of the treatment. This questionnaire is administered at the end of the intervention to assess overall satisfaction.

2.3.2. Intervention instruments

Resources used to conduct exposure therapy in all conditions (360°, VR, IM).

To make the exposure in all conditions (360°, VR, IM):

- Script for situations to face.** A script was created for each situation describing each scene in detail. This ensured that participants in the Imagination (IM) condition could immerse themselves in the same situations as those in the VR or 360 videos conditions. The script aimed to create consistency in the experience across all conditions.
- Common hierarchy of situations.** A common hierarchy was developed, consisting of 5 situations that participants would face in the exposure process. This hierarchy aimed to progressively expose participants to different stages of exam-related stress, from pre-exam anxiety to post-exam concerns. The situations, in order of increasing anxiety, were:

1. Before entering the exam
2. Receiving the exam paper
3. Taking the exam
4. Submitting the exam
5. Receiving negative qualifications

Resources used to conduct exposure therapy in virtual reality (VR):

- PICO G2 glasses.** These glasses, using the Amelia Virtual Care (Psious) virtual reality software, enabled the display of scenes created for psychological intervention purposes.
- Amelia Virtual Care (Psious) virtual reality software.** This study used mentioned software to project selected scenes from its library, designed for psychological intervention, onto the PICO G2 glasses. The selected scenes were taken from the "Exam Exposure" section, specifically the "University" mode. All scenes from this section were used: "Hallway" simulated a scene where participants waited before the exam (Fig. 1A) and the viewing of negative qualifications after completing the exam (Fig. 1E); "Classroom" simulated a scene where the exam was distributed (Fig. 1B); "Exam" simulated a scene in which the student was taking the exam (Fig. 1C) and handing in the exam afterwards (Fig. 1D). In all scenes, aspects such as the avatar's gender, skin tone, and the number of students present could be customized.
- Amelia Virtual Care (Psious) Mobile Application.** This application enabled the connection of three Android and iPhone mobile devices to the Amelia Virtual Care (Psious) virtual reality software. It facilitated multiple students' participation in VR exposure therapy using mobile devices, addressing the limitation of having only one PICO G2 headset.
- Cardboard VR Headsets (Psious).** Three cardboard headsets compatible with Android and iPhone mobile devices were used to implement the VR described in the previous paragraph.

Resources used to conduct exposure therapy in 360° videos (360°):

- Insta360 X3 Camera.** This camera was used to record the 360° videos later employed in the intervention with participants in the 360° exposure condition. Five videos were recorded with the help of an adjustable tripod to simulate a first-person perspective.

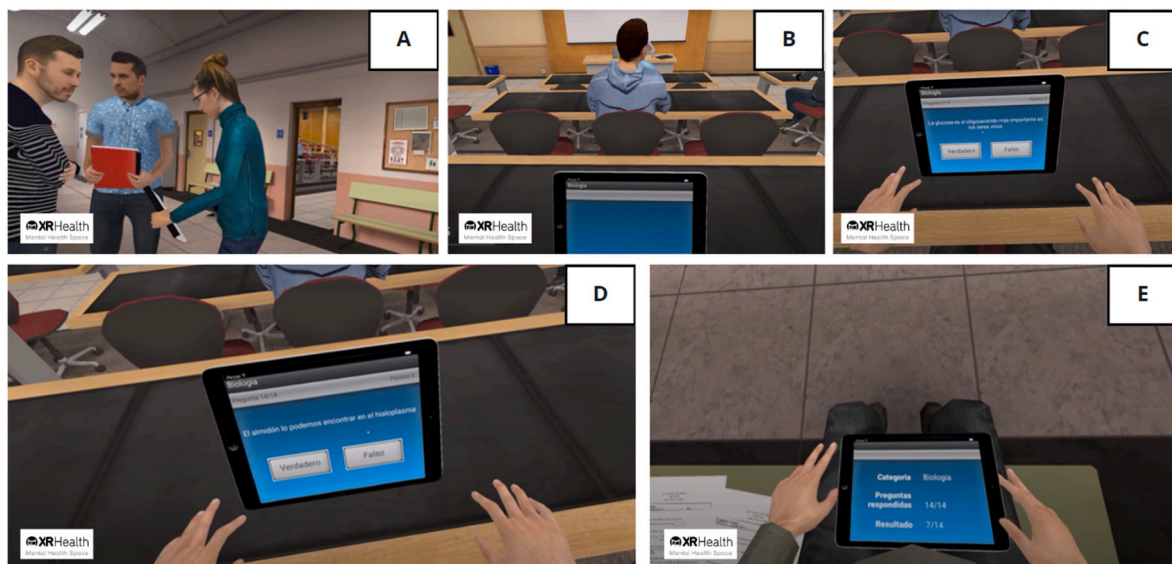


Fig. 1. Scenes used for participant exposure in virtual reality with XR health software.

- b) *Cardboard VR Headsets (Psiious)*. Three cardboard headsets compatible with Android and iPhone mobile devices were used to play the 360° videos.
- c) *Mobile Devices*. Three mobile device models were used: Xiaomi Mi A1, Xiaomi Redmi Note 8 Pro, and Samsung Galaxy A40. The choice of devices was irrelevant, as they were readily available at SUAS with the necessary applications already installed for conducting the intervention.
- d) *Insta360 Studio*. The “Insta360 Studio” editing software was used due to its ease of use and recommendation by the camera’s manufacturer. The software was employed to edit aspects such as lighting, focus, and sound, and to export the videos into a format compatible with various platforms, including YouTube, which was used for the intervention.
- e) *360° Videos*. The five 360° videos were recorded using the Insta360 X3 camera at the facilities of the Faculty of Health Sciences at the University of Burgos, with permission from the dean and consent from the students and professors involved—except for one scenario, which was recorded in a private residence.

The recordings were completed in a single day, and they were edited to adjust aspects such as lighting, sharpness, sound, and duration using the InstaStudio 360° application. Once edited, the videos were processed in 360° video format for upload to a compatible platform (YouTube), where a private channel was created to host them. A total of five 360° videos were created, corresponding to the scenes offered by the Amelia Virtual Care virtual reality software (see Fig. 2).

- Scene A “Entering the Classroom”: the participant is already seated in the classroom along with two other classmates and observes how the rest of the students, displaying nervous behaviors, enter the classroom and take their seats to prepare for the exam.
- Scene B “Distributing the Exam”: in this video, all the students are seated in the classroom, waiting for the exam to be distributed. The teacher proceeds to hand out the exam and provides instructions on how to complete it.
- Scene C “Taking the Exam”: the video depicts a classroom scenario where the students are focused on completing the test.
- Scene D “Collecting the Exam”: after the exam is finished, the students raise their hands, and the teacher approaches each one individually to collect their exam papers.

- Scene E “Viewing Negative Grades”: the participant is in a room in front of a computer, reviewing the results from the first exam session, in which they received a poor grade.

- f) *YouTube Platform*. This platform was chosen because it supports 360° video files, maintaining much of their quality. A channel was created specifically for this purpose. The videos were kept in “private” format so they could only be viewed from authorized devices, thereby preventing unauthorized downloads.

2.4. Procedure

The general procedure was carried out in the following phases, following [Serrano-Pintado and Escolar-Llamazares \(2014\)](#) and [Serrano Pintado et al. \(2002\)](#):

2.4.1. Participant selection and pre-treatment trait anxiety assessment

Participants were able to access the intervention program through advertising posted by University of Burgos Communications Office on social media and communication channels of the University of Burgos in January 2023. All students who wanted to enrol in the Test Anxiety Management Program (experimental group) or in the Study Techniques Program (control group) offered by the University of Burgos Health Care Service (SUAS-UBU) were individually interviewed, during which they were administered the STAI-R and the IAE online, using the Microsoft Forms tool. This allowed for the assessment of anxiety related to untapped topics and trait anxiety related to exams. The experimental group was also informed that this was a group treatment aimed at teaching strategies and skills to cope with and resolve their exam anxiety and at the end of the session, participants were asked to fill out a form providing their personal information, dates of their upcoming exams arranged by difficulty, their availability, reasons for wanting to participate in the program, the benefits they expected to gain, and a commitment to attend and maintain confidentiality.

2.4.2. Pre-treatment state anxiety assessment

The students mentioned earlier, in February 2023, after completing one of the exams they judged as difficult, filled out the STAI-E and the CRAP, also in an online format through the Microsoft Forms tool. This allowed for the assessment of state anxiety related to untapped topics and exams.

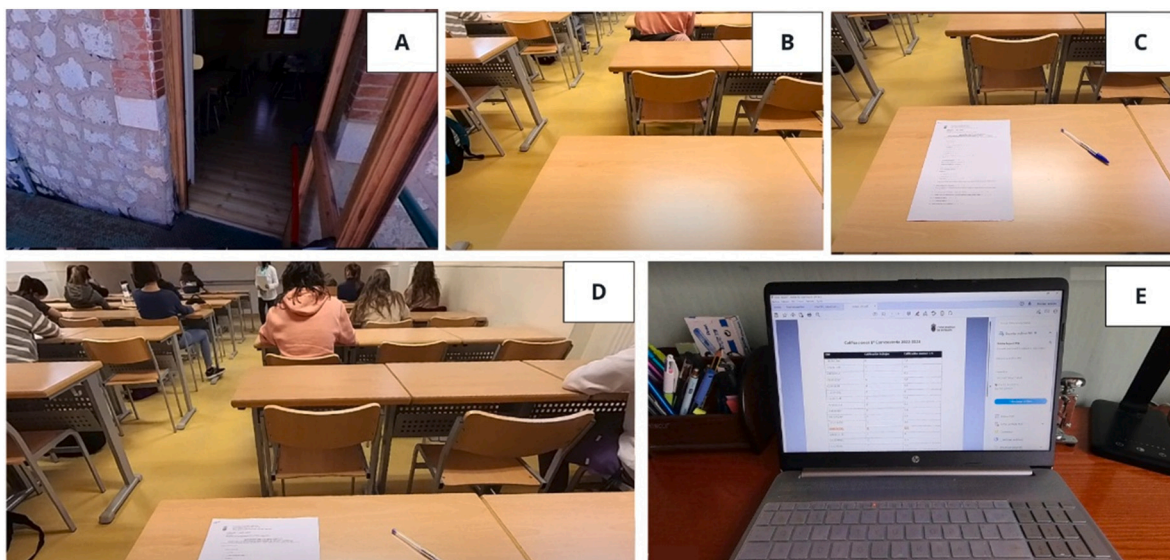


Fig. 2. Scenes used for participant exposure with 360° videos.

2.4.3. Sample selection

The two evaluation phases mentioned earlier made it possible to assess the levels of trait and state anxiety related to topics not related to exams, as well as the levels of trait and state anxiety specific to exams. Ten students who scored the highest in both questionnaires were selected to take part in the experimental group. The remaining students were assisted by the University of Burgos Health Care Service (SUAS-UBU) in the areas where they truly needed help, whether due to generalized anxiety disorders, study behavior deficits, or lack of self-control skills in their study behavior. Another 10 students who wanted to participate in the Study Techniques Program were selected to take part in the control group.

2.4.4. Assignment of subjects to experimental groups

Using simple random sampling, we assigned the ten selected students from the experimental group to the three experimental conditions. Four students received exposure training through 360° videos (360), three received it with virtual reality (VR), and three were trained in exposure through imagination (IM). For the proper development of the intervention and based on the students' availability, two training groups were established: a morning group with five students (2 in 360, 1 in VR, 2 in IM) and a midday group with the remaining five (2 in 360, 2 in VR, 1 in IM).

2.4.5. Program implementation

As mentioned earlier, the Test Anxiety Control Program is based on a stress inoculation paradigm. It consists of three phases: educational, practical, and application. Two therapists participated in all phases of the program.

- a. *Educational phase.* This phase was conducted over a single session. All students were provided with an explanation of test anxiety as a problem encompassing cognitive, somatic, and behavioral components that interact with one another. Information was gathered on how the problem manifested for each participant across the three response levels. Subsequently, the treatment objectives were presented, emphasizing their gradual achievement. The procedures to be used to meet these objectives were justified and described, and the importance of completing the tasks assigned between sessions was also mentioned. Students in the IM condition were informed that exposure training would be conducted through imagination. Those in the VR condition were told that their exposure to anxiety-provoking situations would involve virtual reality scenes. Finally, students in the 360° condition were informed that their exposure would be carried out using 360° videos.

- b. *Practical phase.* During this phase, students learned and practiced the described skills over fourteen sessions.

- b.1. *Relaxation training.* All participating students underwent relaxation training. In the first relaxation session, the benefits for relaxation training were explained, presenting it as a skill to actively manage anxiety in any situation, particularly in test-related scenarios. This relaxation training followed the progressive relaxation procedure of [Jacobson \(1925\)](#) but using a version even shorter than that of [Bernstein and Borkovec \(1973\)](#) ([Serrano Pintado & Escobar Llamazares, 2015](#)). Additionally, participants from both groups were trained in cue-controlled relaxation. They were instructed to focus on their breathing and subvocalize the verbal cue "calm" with each exhalation once they reached a deep state of relaxation. This was to associate the cue with their relaxed state.

- b.2. *Training in domain of Subjective Units of Anxiety (SUAs).* Students were trained to use an SUAs scale to evaluate and communicate the subjective level of anxiety experienced and the level of relaxation achieved after practice. A scale ranging from 0 (not tense at all) to 100 (extremely tense) was used ([Serrano Pintado et al., 2002](#)).

- b.3. *Training in self-verbalization control.* This training focused on explaining the negative effects of certain self-verbalizations

triggered during test situations and how alternative self-verbalizations could mitigate these effects. Students were informed that individuals with test anxiety often engage in negative self-talk, which acts as a distractor and increases worry and tension. Students were then asked to identify the negative self-verbalizations they used when facing an exam. Each student created an inventory of disturbing self-verbalizations related to exams (before, during, and after). Using this information, a list of 8 common negative self-verbalizations was created for the morning group and another for the midday group. These verbalizations were analysed one by one through logical questioning to assess their validity and usefulness. For each negative self-verbalization, the group collaboratively formulated one or more alternative self-verbalizations that were positive, rational, task-oriented, and suited to the individual. The students were trained in thought-stopping techniques and the replacement of the 8 common verbalizations using external, subvocal, and covert cues. At the end of each session, students were encouraged to practice the session's items at home.

- b.4. *Hierarchy construction.* A common hierarchy of 5 anxiety-provoking situations related to exams was developed, ordered hierarchically according to SUAs (as described in section 2.3.2).

- c) *Application phase.* In this phase, the coping skills learned were applied to confront the anxiety-provoking situations in the hierarchy. The guided practice for each of the three conditions is detailed below.

For students in the Imagination Exposure (IM) condition, training involved practicing imagination with some situations from the hierarchy. Subsequently, each situation in the hierarchy was vividly imagined by the students, who faced the associated anxiety using relaxation and thought-stopping techniques. Multiple trials were conducted with each situation until tension was reduced. For each situation and every attempt by each participant, the Subjective Units of Anxiety (SUAs) experienced while imagining the anxiety-provoking scenario and after successfully coping with it were recorded.

The sequence was repeated until most students reduced their SUAs to zero for a specific scenario. At the end of each session, the number of times each scene had to be presented for all group members to significantly lower their anxiety was documented.

The guided practice for students in the Virtual Reality (VR) Exposure and 360° Video (360°) Exposure conditions was identical to the process described above, but the VR group, the hierarchy scenes were presented through virtual reality using PICO VR headsets and mobile VR viewers (scenes described in [Fig. 1](#)), and in the 360 group, the hierarchy situations were presented through 360° scenes viewed using VR headsets (scenes described in [Fig. 2](#)).

Once the students in all three exposure conditions had mastered managing the anxiety induced by the hierarchical situations, they were exposed to real anxiety-provoking scenarios related to exams. In the final session, students were asked to create a new list of their final exam dates for the second semester, ordered by perceived difficulty ([Serrano Pintado et al., 2002](#)).

The students assigned to the active control group participated in a structured Study Techniques Program designed to strengthening their overall learning strategies. The intervention was delivered over the course of five weekly sessions, each lasting one hour, and was designed to address key dimensions of effective academic performance.

Specifically, the program included one session focused on planning and time management, two sessions dedicated to the development and practice of specific study techniques, and two sessions targeting self-regulation and motivation, with the objective of fostering greater autonomy and persistence in learning.

This program was designed and implemented by the University of Burgos Health Care Service (SUAS-UBU), and its structure was informed by previous empirical studies such as those conducted by ([Al-](#)

Awwad et al., 2021; Alzahrani et al., 2018).

2.4.6. Post-treatment evaluation

At the end of the intervention and before the second-semester exams began, trait anxiety regarding untreated topics and test-related trait anxiety were reassessed using the STAI-R and IAE scales. Additionally, in the experimental group, information was gathered on student satisfaction with the type of exposure they had been trained with, using the CRES-4 questionnaire. Similarly, as in the pre-treatment evaluation, all of the students (experimental group and control group), after completing one of their most challenging exams, state anxiety related to untreated topics and test-specific state anxiety were measured using the Anxiety State Inventory (STAI) and CRAP scale. For all students, there was a minimum interval of ten days between the assessment of trait anxiety components and the evaluation of state anxiety components. All the previously mentioned questionnaires were administered online via Microsoft Forms.

Lastly, verbal feedback was collected from the experimental group students regarding their mastery of in vivo situations (e.g., reassessment of exam situations, tension reduction, reduction of physiological manifestations, elimination of avoidance and escape behaviors, among others). Information on the generalization of skills to unrelated stimuli (e.g., fear of driving alone) was also gathered (Serrano Pintado et al., 2002, 2016).

2.5. Ethical procedure

The study was conducted in compliance with all ethical and legal aspects of research and the rights of participants. Prior to its commencement, a favourable report was obtained from the Bioethics Committee of the University of Burgos (registration number IR 11/2023). Explicit informed consent was requested from the participants, in which the study objectives and the nature of their participation were clearly explained. Compliance with Organic Law 3/2018, of December 5, on Personal Data Protection and Guarantee of Digital Rights, was ensured. Confidentiality in the handling of personal data was guaranteed at all times.

All data collected for this study were systematically anonymized to prevent any personal identification.

2.6. Analyses

First, the assumptions of normality (skewness, kurtosis, Shapiro-Wilk test) and homogeneity of variance (Levene's test) were verified. However, due to the small sample size ($n = 10$), non-parametric tests were chosen (Berlanga Silvestre & Rubio Hurtado, 2012). Second, descriptive analyses were conducted for the different variables studied: trait and state anxiety for untreated topics (STAI), trait test anxiety (IAE), state test anxiety (CRAP), and satisfaction (CRES-4). Third, to test the research objectives a Wilcoxon signed-rank test for related samples was used to determine whether there were statistically significant differences between pre-training (PRE) and post-training (POST) scores across the different questionnaires within the experimental group and the control group. Also, a Kruskal-Wallis's test was employed to assess whether there were differences between the three training groups (IM, VR, 360) in the post-training scores of the various questionnaires and the satisfaction questionnaire. Effect sizes were calculated using the epsilon-squared coefficient (E_p^2) (Ventura-León & Ventura-León, 2019), providing additional support for the observed group differences. Finally, a Kruskal-Wallis's test was conducted to analyse the individual items of the satisfaction questionnaire across the three experimental conditions.

These analyses were performed using the SPSS v.28 statistical package (IBM Corporation, 2022). A two-tailed significance level of 0.05 was used to determine statistical significance.

3. Results

The data were analysed according to the study objectives.

3.1. Explore whether the test anxiety management program with the different types of exposure implemented (360, VR, and imagination) reduces test anxiety levels (pre- and post-intervention questionnaires: STAI, IAE, CRAP)

The mean scores of Test Anxiety Management Program participants on the STAI State Anxiety scale before the intervention were 89.20 ($SD = 19.71$) (median = 98.00). After the intervention, the scores decreased to 61.20 ($SD = 35.43$) (median = 62.50). A Wilcoxon signed-rank test for related samples indicated that the sum of negative ranks was 51.00, compared to a sum of positive ranks of 4.00. The effect size was large (Cohen, 1988).

Before the intervention, the experimental group participants scored an average of 91.40 ($SD = 10.37$) (median = 98.00) on the STAI Trait Anxiety scale. These scores decreased to 60.50 ($SD = 32.95$) (median = 57.50) after the intervention. The Wilcoxon signed-rank test showed that the sum of negative ranks was 55.00, with a sum of positive ranks of 0.00.

On the Trait Test Anxiety questionnaire (IAE), participants of the Test Anxiety Management Program initially scored 65.40 ($SD = 8.54$) (median = 66.00), which decreased to 47.50 ($SD = 16.86$) (median = 39.50) after the intervention. A Wilcoxon signed-rank test showed that the sum of negative ranks was 50.00, compared to a sum of positive ranks of 5.00.

The initial mean scores of the experimental group on the CRAP State Test Anxiety questionnaire were 58.60 ($SD = 9.19$) (median = 59.50), which decreased to 40.40 ($SD = 15.87$) (median = 38.00) following the intervention. The Wilcoxon signed-rank test showed that the sum of negative ranks was 55.00, with a sum of positive ranks of 0.00 (see Table 2).

In order to further address Objective 1, and to provide contextual reference, a comparison with the active control group (student who participated in the Study Techniques Program) was also carried out. This analysis aimed to verify whether the reductions observed in the experimental group could be attributed to the Test Anxiety Management intervention itself, rather than to the mere passage of time between the pre and post assessments (see Table 3).

The mean scores of the control group on the STAI State Anxiety scale before the intervention were 65.90 (median = 62.50). After the intervention, the scores decreased slightly to 59.90 (median = 55.00). A Wilcoxon signed-rank test for related samples revealed that the sum of negative ranks was 28.00, with a sum of positive ranks of 17.00., suggesting that no meaningful change occurred in state anxiety among control group participants. The effect size was small.

The active control group showed mean scores of the STAI Trait Anxiety scale of 69.20 (median = 72.50) before the intervention, minimally decreasing to 67.50 (median = 67.50) after the intervention. A Wilcoxon signed-rank test for related samples revealed that the sum of negative ranks was 27.50, with a sum of positive ranks of 17.50, indicating stability in trait anxiety levels among participants in the control group. The effect size was also small.

The mean scores of the control group on the IAE scale before the intervention were 54.60 (median = 55.00). After the intervention, the scores decreased to 50.40 (median = 51.00). A Wilcoxon signed-rank test for related samples revealed that the sum of negative ranks was 35.50, with a sum of positive ranks of 9.50.

The control group scored 42.20 (median = 39.50) in the CRAP scale before the intervention. After the intervention, the scores highly increased to 43.10 (median = 46.00). A Wilcoxon signed-rank test for related samples revealed that the sum of negative ranks was 28.50, with a sum of positive ranks of 26.50. This result suggests no change in academic state anxiety among the control group participants. The effect size

Table 2

Comparison of pre and post intervention scores in the experimental group. Wilcoxon signed-rank.

	PRE	POST	Dif. Score	Sum of negative ranks	Sum of positive ranks	Z	Sig.	r
STAI E	89.20	61.20	28	51.00	4.00	-2.397	0.017*	-0.76
STAI R	91.40	60.50	30.90	55.00	0.00	-2.810	0.005*	-0.89
IAE	65.40	47.50	17.90	50.00	5.00	-2.193	0.028*	-0.69
CRAP	58.60	40.40	18.20	55.00	0.00	-2.805	0.005*	-0.89

* Significance $p < 0.05$.**Table 3**

Comparison of pre and post intervention scores in the control group. Wilcoxon signed-rank.

	PRE	POST	Dif. Score	Sum of negative ranks	Sum of positive ranks	Z	Sig.	r
STAI E	65.90	59.90	6.00	28.00	17.00	-0.654	0.514	-0.21
STAI R	69.20	67.50	1.70	27.50	17.50	-0.611	0.514	-0.19
IAE	54.60	50.40	2.70	35.50	9.50	-1.543	0.123	-0.49
CRAP	42.20	43.10	-0.90	28.50	26.50	-0.102	0.919	-0.03

was negligible (see Table 3).

3.2. If a significant reduction is found between pre-post scores, check whether it occurs to the same extent with any of the three types of exposure used

Once it was observed that the treatment appeared to be effective in reducing anxiety toward untreated topics and both trait and state anxiety in students, the aim was to compare whether there were significant differences between the three conditions. For this, the differential post-pre intervention scores of each condition were considered.

In the STAI state questionnaire, participants in the 360° video condition showed a mean rank of 5.13; participants in the VR condition scored 5.83, and in the imagination condition, the score was 5.67, indicating that all three conditions reduced state anxiety toward untreated topics similarly.

In the STAI trait questionnaire, students in the 360° video condition had a mean rank of 5.50, the VR group scored 5.67, and the imagination group 5.33. This means that the experimental condition was not a determining factor in the reduction of trait anxiety toward untreated topics.

In the IAE questionnaire, participants in the 360° video condition had a mean rank of 4.75, those in the VR group scored 7.17, and the students in the imagination condition scored 4.83.

Finally, in the CRAP questionnaire, students in the 360° video condition had a mean rank of 5.38, those in the VR group scored 5.67, and students in the imagination condition 5.50. This indicates that the reduction in state anxiety toward exams occurred similarly across the three conditions (see Table 4).

Table 4

Comparison of mean rank in the STAI E-R, IAE, and CRAP questionnaires based on the exposure condition. Kruskal-Wallis test.

*Differential Score	360	RV	IM	H	Sign.
STAI E (STAI E pre- STAI E post)	5.13	5.83	5.67	0.107	0.948
STAI R (STAI R pre- STAI R post)	5.50	5.67	5.33	0.019	0.991
IAE (IAE pre – IAE post)	4.75	7.17	4.83	1.308	0.520
CRAP (CRAP pre – CRAP post)	5.38	5.67	5.50	0.016	0.992

* Significance $p < 0.05$.

3.3. If participant satisfaction with the exposure differs based on the type of exposure assigned, a satisfaction questionnaire

Participants rated the items on the ad hoc satisfaction questionnaire similarly. Specifically, participants in the 360° video condition had an average score of 9.08 ($SD = 0.76$), those in the VR condition scored 8.4 ($SD = 0.32$), and participants in the imagination condition scored 8.64 ($SD = 0.18$), all out of a total score of 10. Indicating that the type of intervention did not influence the overall satisfaction score.

Below, the scores obtained by participants on each item based on the assigned exposure condition are presented (see Table 5).

4. Discussion and conclusions

As this is a pilot study, the findings should be interpreted as purely exploratory. Regarding the first objective of the study, which aimed to evaluate the reduction of exam anxiety through the Test Anxiety Management Program with different types of exposure (360°, VR, and imagination), it was found that the participants in the experimental group tend to reduce both general anxiety and specific exam anxiety. An especially relevant aspect was the notable reduction in general anxiety levels, including both state anxiety (temporary) and trait anxiety (lasting). These results are encouraging and suggest that the training program with different exposure types could be effective in reducing exam anxiety in university students.

The reduction in anxiety observed in all three experimental groups after the intervention is consistent with previous studies. In line with research by (Orso et al., 2020; Serafini & Chittaro, 2025), the use of 360° videos has proven particularly effective in reducing anxiety in

Table 5

Comparison of mean ranks of satisfaction questionnaire by type of exposure. Kruskal-Wallis test.

	360° videos	VR	Imagination
Item 1. Type of exposure	5.63	5.17	5.67
Item 2. Duration of exposure	5.00	5.33	6.33
Item 3. Frequency of exposure	5.63	4.00	6.83
Item 4. Intensity of exposure	6.75	4.33	5.00
Item 5. Quality of exposure	7.88	3.33	4.50
Item 6. Prior information	5.75	3.67	7.00
Item 7. Adequacy of the situations faced	7.75*	2.17*	5.83*
Item 8. Therapist support	4.75	6.00	6.00
Item 9. Perceived control level	5.75	5.17	5.50
Item 10. Overall effectiveness of exposure	6.75	4.83	4.50
Total Score	6.88	2.33	6.83

* Significance $p < 0.05$.

evaluative situations. This finding supports that all three exposure techniques employed could be not only effective for managing exam-related anxiety but also contribute to a broader reduction in general anxiety. As a result, these interventions appear to support their potential application as therapeutic tools in academic contexts, suggesting benefits that may extend beyond evaluative situations and promote the overall emotional well-being of students.

In contrast, the active control group did not show statistically significant differences between pre and post intervention measures in any of the questionnaires administered. The absence of meaningful improvement in the control group suggests that the reductions in both general and test-related anxiety observed in the experimental group can be attributed to the Test Anxiety Management Program rather than to external factors such as the passage of time or repeated testing. It is also worth noting that, as previously mentioned, the control group did not share the same baseline levels of measures as the experimental group and therefore can only be considered as a point of reference, and the findings should be understood only as exploratory and hypothesis-generating.

These results are consistent with previous research indicating the effectiveness of anxiety-reduction therapies in university settings. Various studies have documented that structured interventions, including cognitive-behavioral strategies, relaxation techniques and test-specific coping mechanisms, can lead to significant decreases in both general and academic-related anxiety among students (Oliveira et al., 2023; Yessimbekova et al., 2025).

Concerning the second objective, which aimed to *compare the effectiveness of the three exposure types* (Imagination, VR, 360°), the results reveal that all three coping strategies were equally effective in reducing exam anxiety. The magnitude of anxiety reduction did not show statistically significant differences between the exposure modalities, suggesting that all of them could be considered potentially useful interventions for helping students manage anxiety associated with evaluative situations.

Nevertheless, a tendency was observed for students exposed to the VR condition to present a greater reduction in anxiety, although these differences did not reach statistical significance.

This finding is significant, as it implies that the inclusion of technology in interventions does not diminish the effectiveness of traditional techniques like imagination. This allows educational institutions and therapists to select any of these options based on specific needs without compromising the treatment's efficacy.

Each method has its particular advantages. Virtual reality, while immersive and effective, requires advanced and costly technological infrastructure, which can limit its accessibility. On the other hand, 360° videos offer a similar immersive experience at significantly lower costs and greater flexibility, as they can be viewed on common devices such as smartphones or computers with inexpensive headsets (Rubin et al., 2022; Valero Aguayo, 2023). Imagination, although it does not require technological resources, depends largely on the individual's ability to mentally visualize stressful situations, which may not be equally effective for all students.

The choice of technique may depend on factors such as resource availability, technology accessibility, and individual student preferences. This facilitates the personalization of interventions, ensuring that students can benefit in the most appropriate way for their specific needs and contexts, regardless of environmental limitations or individual abilities.

Finally, regarding the third objective, which sought to *assess whether participants' satisfaction with the exposure varied based on the type of exposure assigned*, the results did not show statistically significant differences. However, a tendency was observed for participants who used 360° videos to report higher satisfaction and engagement levels compared to those who used virtual reality or imagination. This pattern suggests that 360° videos might be perceived as a particularly engaging and immersive format for students, although further research is needed

to confirm this trend.

The immersive experience of 360° videos, which naturally combines visual and auditory elements, seems to facilitate a greater connection with the exposure environment, making the experience more realistic and less abstract. In contrast, imagination largely depends on the individual's ability to create and maintain clear mental images, which can influence its effectiveness and perception. These results align with those reported by (Kwon et al., 2020; Meekes & Stanmore, 2017), who highlighted that the realism and intrinsic appeal of immersive technologies contribute to greater adherence and satisfaction in treatments.

Moreover, in the therapeutic context, satisfaction with the method used is key in treatment adherence. The tendency of a higher satisfaction observed with 360° videos may lead to greater commitment and more active participation during the intervention. This not only could improve the participant's experience but also increase the likelihood of successfully completing the treatment. Additionally, the potential of 360° videos to allow personalized adaptations to each student's needs enhances their usefulness as a therapeutic tool, promoting more effective and satisfying interventions.

In conclusion, the findings of this study suggest that all three types of exposure were effective in reducing participants' perceived anxiety, with no significant differences between them. A tendency was observed for the VR condition to yield slightly greater reductions in anxiety compared to 360° videos and imagination, although participants reported marginally lower satisfaction with this modality. In contrast, 360° videos showed a trend toward higher satisfaction and engagement than both VR and imagination, even if this difference was not statistically significant either.

This study provides preliminary data suggesting that all exposure modalities may be promising; however, larger-scale controlled trials are needed to confirm their efficacy.

4.1. Implications

In addition to these findings, it is important to consider the practical implications of this study, particularly for educators and academic tutors. While tutors may not be expected to have the necessary tools to teach adaptive coping strategies directly to their students, it is crucial that they are aware of the university's support services so they can guide or refer students to appropriate resources when needed. This knowledge allows tutors to play a key role in connecting students with evidence-based resources, promoting both immediate anxiety reduction and longer-term coping skills.

At a broader level, these insights can guide institutional policies, supporting the integration of technological tools in academic programs and fostering a holistic approach to student well-being, always guided by a multidisciplinary team.

4.2. Limitations and future research directions

One of the main limitations of this study was the small sample size ($n = 20$) and the lack of homogeneity in the sample (18 women, 2 men), which limits the generalizability of the results. Future research should focus on recruiting a larger number of participants, including a more balanced sample in terms of gender, age, and cultural diversity. This would allow for more robust statistical analyses and provide conclusions that are more representative and applicable to different populations of university students.

Another limitation of the study that should be acknowledged, is related to the active control group. Since the control group did not present comparable baseline levels of anxiety to those of the experimental group, it cannot be considered a fully equivalent comparison group. As a result, its role is limited to serving as a reference point rather than allowing for direct contrasts with the experimental group. Future research should consider using a control group that is more comparable to the experimental group. This would allow for meaningful

comparisons and strengthen the ability to attribute observed changes specifically to the intervention. Randomized allocation or matching procedures could help ensure equivalent between groups at baseline, reducing potential biases.

A further limitation to consider is the potential influence of regression to the mean, which may have contributed to the observed reductions in anxiety in the experimental group. Since participants with high scores tend to show some movement toward the average upon subsequent measurement, part of the change observed in this study might reflect this statistical phenomenon rather than the pure effect of the intervention itself. Therefore, caution is warranted when interpreting the magnitude of anxiety reduction and future studies with larger, randomized samples are needed to more clearly distinguish true intervention effect from statistical artifacts.

Additionally, it was identified that the temporal proximity of the post-intervention assessment to the final exams could have influenced anxiety scores. Future studies should explore the implementation of the intervention at different times during the academic cycle, as well as evaluate the optimal session duration and the number of repetitions needed to maximize the treatment's benefits. This would help identify the most suitable time to carry out the intervention and obtain more representative and long-lasting results.

Since immersion and user experience can significantly influence the effectiveness of technology-based treatments, it is recommended that objective scales be used to measure participant immersion in future studies. These scales could be complemented with more internally consistent satisfaction questionnaires, allowing for a more precise and comparative assessment of the different exposure techniques used. Furthermore, research could explore how immersion specifically affects anxiety reduction and treatment adherence.

This study focused on exam anxiety in university students, but the results suggest that this modalities of exposure could be effective in other contexts and for treating different types of anxiety. Future research should explore the application of this exposure methods in other educational settings, as well as its effectiveness in treating other forms of anxiety, such as social anxiety or generalized anxiety. It would also be interesting to evaluate its effectiveness in populations with specific disorders, such as borderline personality disorder, where treatment, personalization and adaptation are especially crucial.

Finally, given the potential of 360° videos to be adapted to individual needs, future research could research further into how scene personalization and the ability to adjust content in real-time influence treatment effectiveness.

Beyond technological adaptations, future studies could also benefit from incorporating qualitative and participatory approach, such as Online Photovoice (OPV), Online Interpretative Phenomenological Analysis (OIPA), and Community-Based Participatory Research (CBPR). These methods would allow researchers to engage directly with students, capturing their thoughts, feelings, images, and behaviors from their unique perspectives (Tanhan et al., 2025).

By combining these qualitative insights with quantitative measures, researchers could gain a deeper, more nuanced understanding of how exposure-based interventions operate in academic settings. Such approaches could help identify individual differences in responses, uncover previously overlooked factors influencing anxiety reduction, and inform the design of interventions that are both highly effective and sensitive to students' needs.

Ultimately, integrating technological personalization with participatory, student-centered research methods could provide a stronger foundation for developing tailored, evidence-based strategies and university services that aim at supporting mental health and academic performance.

Authors contribution

I.Q.B. and M.C.E.L.L. wrote the main manuscript text.

I.Q. B. prepared tables and figures.

I.Q. B. and M.C.E.L.L. performed statistical analyzes.

M.A.M.M. reviewed the manuscript.

CRediT authorship contribution statement

Itziar Quevedo-Bayona: Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **María-Camino Escolar-Llamazares:** Writing – review & editing, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **María Ángeles Martínez-Martín:** Visualization, Validation, Supervision, Resources, Project administration, Funding acquisition.

Informed consent to participate

Informed consent to participate was waived by Bioethics Committee of the University of Burgos (registration number IR 11/2023).

Consent to publish

“NA”.

Ethics approval and consent to participate

The study was conducted in accordance with the ethical standards set forth in the 1964 Declaration of Helsinki and its subsequent amendments or equivalent ethical standards. The study was conducted in compliance with all ethical and legal aspects of research and the rights of participants. Prior to its commencement, a favourable report was obtained from the Bioethics Committee of the University of Burgos (registration number IR 11/2023). Explicit informed consent was requested from the participants, in which the study objectives and the nature of their participation were clearly explained. Compliance with Organic Law 3/2018, of December 5, on Personal Data Protection and Guarantee of Digital Rights, was ensured. Confidentiality in the handling of personal data was guaranteed at all times.

All data collected for this study were systematically anonymized to prevent any personal identification.

Funding

This work was supported by a Predoctoral Contract awarded to the first author (University of Burgos, 2024 call, Resolution of 8 January 2025) within the project “Voice assistants and artificial intelligence in Moodle: a path to a smart university” (SmartLearnUni, PID2020-117111RB-I00), funded by the State Research Agency, Ministry of Science, Innovation and Universities, Government of Spain.

Declaration of competing interest

The authors state that they have no competing interests.

Acknowledgements

There is not a special acknowledged.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request ([iquevedo@ubu.es](mailto:iQuevedo@ubu.es)).

References

- Al-Awwad, N. J., Al-Sayyed, H. F., Zeinah, Z. A., & Tayyem, R. F. (2021). Dietary and lifestyle habits among university students at different academic years. *Clinical Nutrition ESPEN*, 44, 236–242. <https://doi.org/10.1016/j.clnesp.2021.06.010>
- Albulescu, I., Labar, A. V., Manea, A. D., & Stan, C. (2024). The mediating role of cognitive test anxiety on the relationship between academic procrastination and subjective wellbeing and academic performance. *Frontiers in Public Health*, 12, Article 1336002. <https://doi.org/10.3389/fpubh.2024.1336002>
- Alzahrani, S. S., Soo Park, Y., & Tekian, A. (2018). Study habits and academic achievement among medical students: A comparison between male and female subjects. *Medical Teacher*, 40(sup1), S1–S9. <https://doi.org/10.1080/0142159x.2018.1464650>
- Anyamene, A. N., & Udeagha, F. U. (2025). Effect of cognitive restructuring technique on test anxiety among secondary school students in Anambra state. *Journal of Guidance and Counselling Studies*, 9(1), 58–69. <https://journals.unizik.edu.ng/jgcs/article/view/5392>
- Berlanga Silvestre, V., & Rubio Hurtado, M. J. (2012). Clasificación de pruebas no paramétricas. Cómo aplicarlas en SPSS. *Revista d'Innovació i Recerca en Educació*, 5(2), 101–113. <https://doi.org/10.1344/reire2012.5.2528>
- Bernstein, D., & Borkovec, T. (1973). *Progressive relaxation training: a manual for the helping professions*. Research Press.
- Campbell, D. T., & Stanley, J. C. (2005). Diseños cuasiexperimentales. *Diseños experimentales y cuasiexperimentales en la investigación social* (pp. 75–114). Buenos Aires-Madrid: Amorrortu.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Academic Press Inc.
- Doğan, U., Sarıcaoglu, H., Acar, S., Türkcapar, H., Sağkal, A. S., Büyükköksüz, E., ... Onay, S. (2025). Unveiling the potential of 360° videos: Tailored interventions for test anxiety within cognitive behavioral therapies. *Current Psychology*, 44(5), 3007–3022. <https://doi.org/10.1007/S12144-025-07376-Z/TABLES/3>
- Doğan, U., Üzmez, H., Dağilgan, B., Sarıcaoglu, H., Acar, S., & Özkarakca, O. (2024). Development of immersive 360° virtual reality videos for intervention with test anxiety. *International Journal of Human-Computer Interaction*, 1–14. <https://doi.org/10.1080/10447318.2024.2434959>
- Dundas, I., & Nygård, I. (2024). Mindfulness for test anxiety and negative self-evaluation in high school. *Current Psychology*, 43(38), 30027–30037. <https://doi.org/10.1007/S12144-024-06557-6/TABLES/3>
- Escobar Llamazares, M. C., Quevedo Bayona, I., Martínez Martín, M. A., Saiz Manzanares, M. C., Sota Rodrigo, C., Mercado Val, E., ... Varela Vázquez, C. (2023). Entrenamiento en relajación muscular con y sin Realidad Virtual en el afrontamiento de la ansiedad ante la evaluación de estudiantes universitarios. Resultados diferenciales en el Inventario de Registro de Indicadores de Tensión y Ansiedad de Cautela. In Á. Matos Martínez, M. M. Simón Márquez, J. J. Gázquez Linares, P. Molina Moreno, & M. Sisto (Eds.), *Investigación y desarrollo de recursos de intervención en contextos clínicos y de la salud* (pp. 87–97). Dykinson, S.L.
- Escobar Llamazares, M. C., & Serrano Pintado, I. (2014). Cómo afecta la ansiedad en el rendimiento de nuestros estudiantes. In F. Miralles Muñoz, & A. M. Cima Muñoz (Eds.), *Los trastornos del desarrollo en la escuela: abordaje biopsicosocial* (pp. 215–238). (CEU ediciones).
- Escobar-Llamazares, C., & Serrano-Pintado, I. (2014). Definition of the construct test anxiety in university students. *Ansiedad y Estrés*, 20(2), 165–180.
- Escobar-Llamazares, M. C., Quevedo-Bayona, I., Martínez-Martín, M.Á., Saiz-Llamazares, M. C., Sota-Rodrigo, C., Mercado-Val, E., ... Varela-Vázquez, C. (2023). Entrenamiento en relajación muscular con y sin realidad virtual en el afrontamiento de la ansiedad ante la evaluación de estudiantes universitarios. Resultados diferenciales en el inventario de registro de indicadores de tensión y ansiedad de cautela. In Dykinson (Ed.), *Investigación y desarrollo de recursos de intervención en contextos clínicos y de la salud* (pp. 87–98).
- Escobar-Llamazares, M. C., & Serrano-Pintado, I. (2019). Intervención cognitivo-conductual en un caso de ansiedad ante la lectura en público: mejora de la fluidez y comprensión. *Revista De Psicología Clínica Con Niños Y Adolescentes*, 6(2), 54–61. <https://doi.org/10.21134/rpcna.2019.06.2.8>
- Eya, N. M., Anumudu, J. I., Nweze, B. N., Dave-Ugwu, P. O., Egbo, J. J., Chukwunwogor, E. O., ... Ugwuanyi, C. S. (2024). Evaluating the efficacy of cognitive restructuring and exposure therapies on secondary school chemistry students' test anxiety: A randomized trial. *Medicine (United States)*, 103(32), Article e39253. <https://doi.org/10.1097/MD.00000000000039253>
- Feixas i Viaplana, G., Pucurull, O., Roca, C., Paz, C., García Grau, E., & Bados López, A. (2012). Escala de satisfacción con el tratamiento recibido (CRES-4). *Revista De Psicoterapia*, 23(89), 51–58.
- Finseth, T., Dorneich, M. C., Keren, N., Franke, W. D., & Vardeman, S. (2025). Virtual reality adaptive training for personalized stress inoculation. *Human Factors*, 67(1), 5–20. https://doi.org/10.1177/00187208241241968/ASSET/ESA588C0-9D42-4EE5-A959-7DF5A5A53B1B/ASSETS/IMAGES/LARGE/10.1177_00187208241241968-FIG6.JPG
- Guo, S., & Liao, S. (2025). The relationship between trait- and state-math anxiety and math engagement: The role of math learning context and task difficulty. *British Journal of Educational Psychology*, 95(3), 750–768. <https://doi.org/10.1111/BJEP.12746>
- Huang, Q., Zhang, H., & Zhou, R. (2023). Stress reappraisal improves the autonomic nervous system response of test anxious individuals: Evidence from heart rate variability. *Neuroscience Letters*, 812. <https://doi.org/10.1016/j.neulet.2023.137372>
- IBM Corporation. (2022). *Tatistical Package For The Social Sciences (SPSS) [Software]*. 28.
- Jacobson, E. (1925). Progressive relaxation. *Source: The American Journal of Psychology*, 36(1), 73–87.
- Kwon, J. H., Hong, N., Kim, K., Heo, J., Kim, J. J., & Kim, E. (2020). Feasibility of a virtual reality program in managing test anxiety: A pilot study. *Cyberpsychology, Behavior and Social Networking*, 23(10), 715–720. <https://doi.org/10.1089/CYBER.2019.0651>
- Lang, P. J. (1968). Fear reduction and fear behavior: Problems in treating a construct. *Research in Psychotherapy*, 3, 90–102.
- Liebert, R. M., & Morris, L. W. (1967). Cognitive and emotional components of test anxiety: A distinction and some initial data. *Psychological Reports*, 20(3), 975–978. <https://doi.org/10.2466/PRO.1967.20.3.975;REQUESTEDJOURNAL:JOURNAL:PRXA>
- Martínez-Otero, V. (2014). Ansiedad en estudiantes universitarios: estudio de una muestra de alumnos de la Facultad de Educación. *Revista de La Facultad de Educación de Albacete*, 29(2), 63–78.
- McMillan, J. R., & Osterhouse, R. A. (1972). Specific and generalized anxiety as determinants of outcome with desensitization of text anxiety. *Journal of Counseling Psychology*, 19, 518–521.
- Medina-Gómez, M. B., Martínez-Martín, M.Á., Escobar-Llamazares, M. C., González-Alonso, Y., & Mercado-Val, E. (2019). Ansiedad e insatisfacción corporal en universitarios. *Acta Colombiana de Psicología*, 22(1), 13–22. <https://doi.org/10.14718/acp.2019.22.1.2>
- Meekes, W., & Stanmore, E. K. (2017). Motivational determinants of exergame participation for older people in assisted living facilities: Mixed-methods study. *Journal of Medical Internet Research*, 19(7). <https://doi.org/10.2196/jmir.6841>
- Meichenbaum, D., & Cameron, R. (1972). *Stress inoculation: A skills training approach to anxiety management*. PhD Thesis. Ontario: University of Waterloo.
- Muñoz, M., & Pérez, E. (1997). Eficacia del entrenamiento en inoculación de estrés en el control de la ansiedad. *Ansiedad y Estrés*, 3(2), 227–247.
- Mur, J. A., Rivas, A., Trueba, D. A., & Girardi, C. I. P. (2022). The relationship between self-efficacy, state-trait anxiety and cognitive test anxiety: a study among university students in Argentina. *Psychological Thought*, 15(2), 75–94. <https://doi.org/10.37708/psyc.v15i2.664>
- Naseri, N. J., & Marashian, F. S. (2025). The effectiveness of stress inoculation training on exam anxiety, distress tolerance, self-compassion, and academic self-efficacy in exam-anxious students. *Journal of Psychologists and Counsellors in Schools*, 35(2), 243–254. <https://doi.org/10.1177/20556365251323356>
- Nwadi, C. L., Edeh, N. I., Uguwunwoti, E. P., Nwokiye, F. O., Nneji, O. S., Anamezie, R. C., ... Okoli, S. N. (2025). Impact of cognitive-behavioral therapy and mindfulness-based stress reduction in mitigating test anxiety and enhancing academic achievement among vocational education students at Nigerian universities. *BMC Medical Education*, 25(1), Article 578. <https://doi.org/10.1186/S12909-025-07130-W>
- Oliveira, C., Pacheco, M., Borges, J., Meira, L., & Santos, A. (2023). Internet-delivered cognitive behavioral therapy for anxiety among university students: A systematic review and meta-analysis. *Internet Interventions*, 31, Article 100609. <https://doi.org/10.1016/j.intvent.2023.100609>
- Orso, V., Pluchinon, P., Mora, D., Miglioranzzi, L., & Gamberini, L. (2020). Experimenting immersive videos to reduce test anxiety in university students. *Annual Review of Cybertherapy and Telemedicine* 2020, 18.
- Osterhouse, R. A. (1969). Inventory of test anxiety. *Journal of Consulting and Clinical Psychology*, 33(3), 336–342.
- Osterhouse, R. A. (1972). Desensitization and study-skills training as treatment for two types of test-anxious students. *Journal of Counseling Psychology*, 19, 301–307.
- Rubin, M., Muller, K., Hayhoe, M. M., & Telch, M. J. (2022). Attention guidance augmentation of virtual reality exposure therapy for social anxiety disorder: A pilot randomized controlled trial. *Cognitive Behaviour Therapy*, 51(5), 371–387. https://doi.org/10.1080/16506073.2022.2053882/SUPPL_FILE/SBEH_A_2053882_SM3081.DOCX
- Sarason, I. G. (1960). Empirical findings and theoretical problems in the use of anxiety scales. *Psychological Bulletin*, 57(5), 403–415. <https://doi.org/10.1037/H0041113>
- Sarason, S. B., & Mandler, G. (1952). Some correlates of test anxiety. *Journal of Abnormal and Social Psychology*, 47(4), 810–817. <https://doi.org/10.1037/H0060009>
- Serafini, M., & Chittaro, L. (2025). Trial of a desktop virtual reality application as a method of exposure for test anxiety: A qualitative study. *Behaviour and Information Technology*, 44(10), 2269–2281. <https://doi.org/10.1080/0144929X.2023.2299738>
- Serrano Pintado, I., Delgado Sánchez-Mateos, J., & Escobar Llamazares, M. C. (2016). A stress inoculation program to cope with test anxiety: Differential efficacy as a function of worry or emotionality. *Avances En Psicología Latinoamericana*, 34(1), 3–18. <https://doi.org/10.12804/apl34.1.2016.01>
- Serrano Pintado, I., & Escobar Llamazares, M. C. (2015). *Cómo vencer tus problemas de ansiedad ante los exámenes*. Pirámide.
- Serrano Pintado, I., Escobar Llamazares, M. C., & Delgado Sanchez-Mateos, J. (2002). Eficacia diferencia de estrategias de afrontamiento en la reducción de la ansiedad ante los exámenes. *Análisis de Modificación Conducta*, 28(120), 523–550.
- Serrano-Pintado, I., & Escobar-Llamazares, M. C. (2014). Description of the general procedure of a stress inoculation program to cope with the test anxiety. *Psychology*, 5(June), 956–965. <https://doi.org/10.4236/psych.2014.58106>
- Spielberger, C. D. (1980). *Test anxiety inventory*. Consulting Psychologists Press.
- Spielberger, C. D., Gorsuch, R. L., & Lushene, R. D. (1970). *Manual for the state-trait anxiety inventory*. Consulting Psychologists Press.
- Spielberger, C. D., Gorsuch, R. L., Lushene, R. E., Buella-Casal, G., Guillén, A., & Nicolás, R. (2015). *STAI. Cuestionario de Ansiedad Estado-Rasgo Adaptación española*. Consult Psychol Press.
- Tan, S. H., Cassidy, J. C., Wong, J. K. C., Khng, K. H., & Leong, W. S. (2025). A systematic review of anxiety identification and leveling in children and adolescents. *Psychology in the Schools*. <https://doi.org/10.1002/PITS.23473;REQUESTEDJOURNAL:JOURNAL:15206807;WGROU:STRING:PUBLICATION>

- Tanhan, A., Taş, B., Agilkaya-Sahin, Z., Hayden, S. C. W., Korkmaz, O., & Gürsu, O. (2025). Perception of online education during COVID-19: Online Photovoice (OPV) and ecological systems theory. *British Journal of Guidance and Counselling*, 53(1), 81–100. <https://doi.org/10.1080/03069885.2023.2247544>
- Valero Aguayo, L. (2023). La realidad virtual para la acrofobia. *Revista Española de Comunicación En Salud*, 14(1), 62–73. <https://doi.org/10.20318/recs.2023.7329>
- Ventura-León, J. L., & Ventura-León, J. L. (2019). Tamaño del efecto para Kruskal-Wallis: aportes al artículo de Domínguez-González et al. *Investigación En Educación Médica*, 8(30), 135–136. <https://doi.org/10.1016/j.riem.2017.07.002>
- Von der Embse, N., Barterian, J., & Segool, N. (2013). Test anxiety interventions for children and adolescents: A systematic review of treatment studies from 2000-2010. *Psychology in the Schools*, 50(1), 57–71. <https://doi.org/10.1002/pits.21660>
- Xu, C., & Wei, H. (2024). The effect of working memory training on test anxiety symptoms and attentional control in adolescents. *Bmc Psychology*, 12(1), 1–11. <https://doi.org/10.1186/S40359-024-01597-W/TABLES/1>
- Yessimbekova, A., Galiyeva, A., Zhexembayeva, Z., Almukhambetova, B., & Abishev, N. (2025). Test anxiety, psychological adaptability, and learning performance: Effects of a mindfulness training intervention on university students. *Journal of Education and Health Promotion*, 14(1). https://doi.org/10.4103/JEHP.JEHP_1245_24
- Zeidner, M. (2007). In P. A. Schutz, & R. Pekrun (Eds.), *Test anxiety in educational contexts: Concepts, findings, and future directions*. Elsevier Academic Press.