

# The Impact of Virtual Dental Clinic Color and Image Modifications on Anxiety Reduction in Undergraduate Dental Students

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## Abstract

Dental students often experience stress due to the curriculum's theoretical and practical demands, which can negatively affect their well-being. Previous research suggests that room colors and images can reduce anxiety in certain populations. However, no studies have examined this effect among dental students. Therefore, this study investigated how color and visual imagery in dental clinics affect anxiety levels in dental students. Participants were dental students experiencing state anxiety. They completed a modified version of the State-Trait Anxiety Inventory (STAI) Form Y-1 before and after entering a virtual reality (VR) dental clinic with altered environmental features. Three types of visual interventions were tested: 1) changing wall colors to blue, green, or yellow; 2) adding images of mountain, sea, or nautilus shell; and 3) combining the most preferred color and image. Paired t-tests were used to analyze changes in anxiety scores, and intergroup differences were examined using the Kruskal-Wallis test, followed by the Wilcoxon Signed-Rank test. Anxiety significantly decreased after exposure to blue and yellow wall colors ( $p < 0.05$ ), with blue being the most preferred. Notably, blue increased positive anxiety scores (PA) and decreased negative anxiety scores (NA) significantly ( $p < 0.05$ ), while yellow only decreased NA scores significantly ( $p < 0.05$ ). Mountain and sea images also significantly reduced anxiety ( $p < 0.05$ ), with the mountain image being the most preferred. Both types of images increased PA and decreased NA scores significantly ( $p < 0.05$ ). The combination of blue walls and a mountain image was effective in reducing anxiety in all participants, but changing the wall color or adding a nature-related image alone was as effective as doing both together. These findings suggest that specific environmental elements—such as color tones and images—within a VR clinical setting can significantly reduce anxiety levels in dental students. Therefore, incorporating simple visual modifications into dental clinic design may be an effective strategy to reduce stress in educational healthcare environments. This highlights the importance of environmental design in supporting student well-being.

## Keywords

Color; Virtual reality; Anxiety reductio; Dental clinic; Academic environment

## 1. Introduction

Stress is the body's response to perceived threats or demands, especially when situations deviate from the norm or arise from new experiences, while anxiety refers to an emotional state characterized by excessive related behavioral disturbances, fear, and worry about future uncertainties (World Health Organization (WHO), 2025)

Although occasional anxiety is common, persistent anxiety that disrupts daily functioning can become problematic (Viveros & Schramm, 2018). It is reported that anxiety can result in restlessness, fatigue, difficulty concentrating, irritability, muscle tension, and sleep disturbance (Viveros & Schramm, 2018). Regarding an educational curriculum, anxiety affects academic achievement by disrupting concentration, memory retrieval, participation, motivation, and self-efficacy, while also contributing to procrastination and physical health issues. This complex relationship involves mechanisms like cognitive interference, attentional biases, diminished perceived control, test anxiety, and negative self-talk, all of which hinder overall academic performance (Konwar et al., 2023).

The dental curriculum is particularly stressful due to the requirement for a combination of theoretical and practical components, leading to limited student downtime. A study by the Thai Dental Schools Network in 1997 revealed that 62.9% of dental students reported a poor quality of life, with 64.2% feeling bored with their studies and practical training. Higher-year students, especially fifth-year students, have more anxiety (Wannakum et al., 2022). In fact, 37.3% of those students said they had mental health problems because of the hard clinical work and criticism from teachers (Kaewsutha et al., 2014). Unfortunately, the dental clinic may symbolize stress and evoke this anxiety. The educational system presents various stressors that impact both lecturers and students. Skinner & Zimmer-Gembeck (2007) stated that while adults typically possess effective coping strategies, children are still developing their skills, emphasizing the need for educators to cultivate less stressful environments that foster healthy coping mechanisms. Therefore, dental schools must balance knowledge delivery with creating conducive learning conditions, considering factors such as lighting, noise levels, and personal space (Simion, 2016).

Previous studies have demonstrated that perception significantly influences emotions (Collier, 1996). Color, as a key component of perception, has been widely reported to affect emotional responses (Hettiarachchi & Perera, 2021), often linked to specific emotional connotations e.g. yellow- happiness (Schloss et al., 2020). A single color can carry a range of meanings and interpretations for different individuals (Kurt & Osueke, 2014). This association may arise from both environmental experiences and cultural factors, such as language, history, and folklore, leading to variations across different cultures (Jonauskaite et al., 2020). Consequently, there has been a concerted effort to utilize color in enhancing emotional well-being. For example, light therapy and the strategic alteration of room colors have been explored as methods for improving mood. Previous research indicates that the color of building interiors can influence emotions (Annamary et al., 2016) and can enhance the quality of learning and memorization, particularly in distance learning environments (Costa et al., 2018; Diachenko et al., 2022). However, cultural and individual factors seem to further modulate the universal tendencies to associate certain colors with specific emotions (Jonauskaite et al., 2020). Therefore, examining appropriate color shades for different situational contexts is essential.

In addition to using color to enhance mood, spending time in nature has been shown to be an effective method for reducing anxiety (Shu et al., 2022). However, in some situations, spending time in nature may be limited and not feasible for alleviating anxiety symptoms. Therefore, viewing images often is used as an alternative for anxiety therapy (Nguyen & Brymer, 2018). Nature-related images encompass a wide spectrum, including mountain and sea images. Additionally, fractal-like pattern images, such as a nautilus shell image, have been reported to help alleviate anxiety, as fractal images feature repeating elements across multiple scales, resembling nature. Observing these images can promote calmness and reduce anxiety, as their repetitive patterns allow the mind to rest and focus, fostering relaxation and positive emotions (Simion, 2016).

As previously mentioned, dental education is associated with high levels of anxiety, influenced by various immutable factors. Minimizing these anxiety-inducing factors can significantly enhance the emotional health and educational efficacy of students. Since color and images have been reported to effectively reduce stress and anxiety levels, this study aimed to investigate the application of color and virtual images of dental units to alleviate stress and anxiety among dental students.

## 2. Materials and Methods

### 2.1 Participants

This study was approved by the Ethics Committee of Naresuan University and the Dental Hospital Committee (P1-0109/2567). To begin, the study included participants who met the following criteria: undergraduate dental students enrolled in the Faculty of Dentistry, Naresuan University, Thailand, at the preclinical level, with no visual or hearing impairments, no chronic illnesses, and no history of medication use affecting mental function. A total of 334 participants were recruited. Demographic, educational status, and anxiety-aggravating factors data were collected. All participants were then screened using the modified (STAI) form Y-1 assessment, which had been tailored for dental students by field experts. The scores indicating that participants experienced an increase in positive emotions (Positive Anxiety) were derived from items 1, 2, 5, 8, 10, 11, 15, 16, 19, and 20, while the scores indicating a decrease in negative emotions (Negative Anxiety) were derived from items 3, 4, 6, 7, 9, 12, 13, 14, 17, and 18. The results were presented as Positive Anxiety (PA) scores and Negative Anxiety (NA) scores. The modified STAI Form Y-1 uses a 4-point Likert scale ranging from 1 (not at all) to 4 (very much so). Scores from multiple items were aggregated to produce PA and NA composite scores. Among the 327 preclinical dental students, 46 were identified with state anxiety and 288 with trait anxiety. Of the 46 participants, 36 volunteered for further research. However, one individual experienced nausea while using the virtual reality (VR) goggles, leaving a final total of 35 participants.

### 2.2 Study Design and Intervention

Upon arrival at the VR test site, 36 volunteered participants were instructed to rest for five minutes before being asked to conduct a pre-intervention anxiety assessment using the modified STAI form Y-1 (Figure 1a). Then, participants were asked to choose their preferred color in VR environments. This study used an intervention with colors and images that had been previously investigated for their potential role in reducing stress, thereby ensuring compliance with ethical standards. For the color component, the study selected three options—blue (RGB: 153, 222, 255), green (RGB: 151, 221, 109), and yellow (RGB: 253, 246, 165)—based on the study by Hettiarachchi & Perera (2021). Participants were then instructed to sit upright and wear a VR headset, which

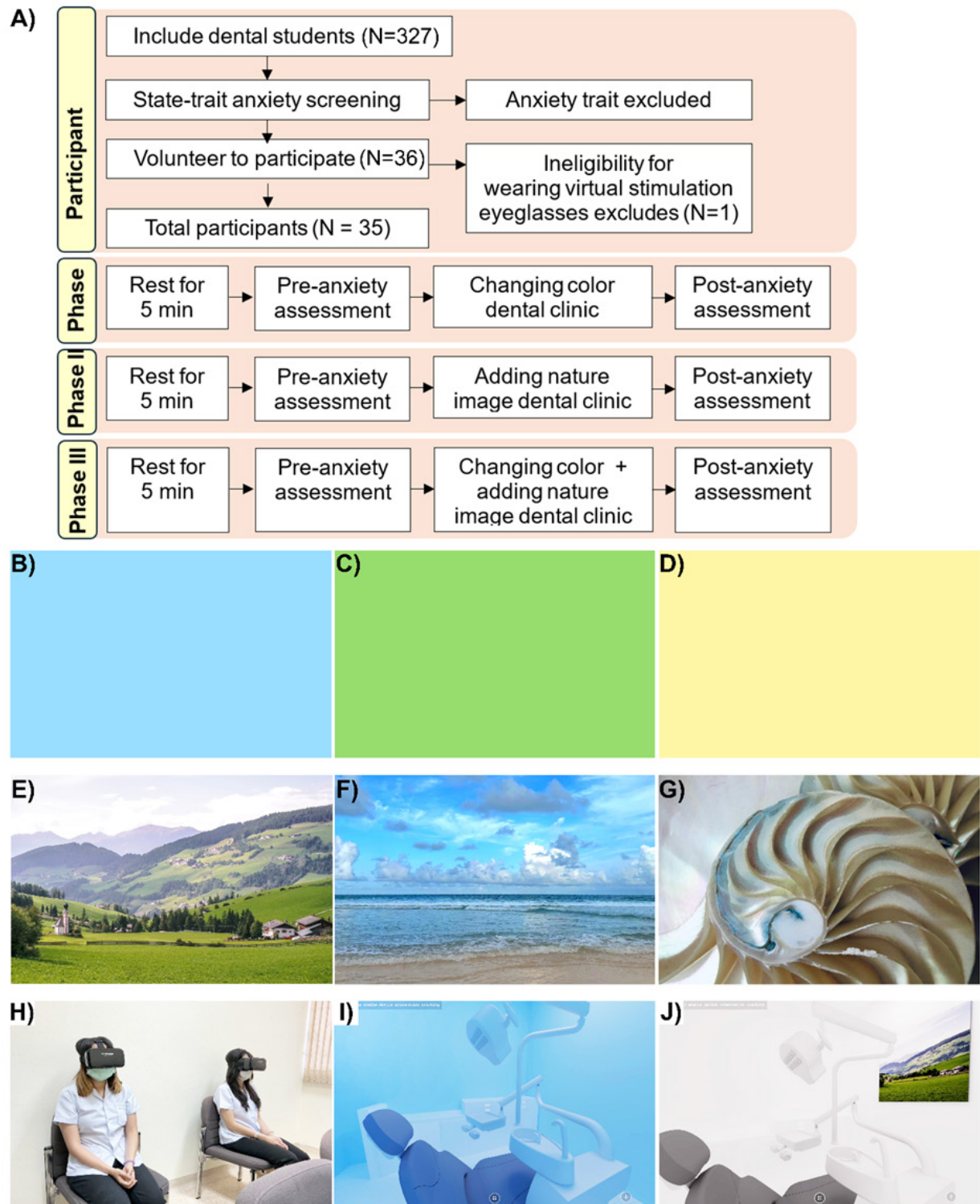
used the Autodesk Rendering software to create virtual environments of a dental clinic within the chosen color. The VR simulation testing and observation continued until participants reported an anxiety reduction, after which a post-intervention anxiety assessment was conducted. No blank (white) wall or other colors reported to relate to stress were used in this study. Each participant selected and viewed only one preferred color. Therefore, the study used a within-subject pre-post design in which each participant's pre-intervention score served as the baseline for comparison.

Having established the influence of color, the study continued to investigate the impact of image on the anxiety reduction in a second experiment conducted one week to one month after the first experiment. This second phase repeated the same process in VR environments but included visualized nature-related images for three options: mountain, sea, and nautilus shell images (Figure 1b-j).

Lastly, the study provided a simulation of both wall color and images based on the most frequently selected options. In the case of participants whose colors and images in the third phase were not their preference, these participants were then instructed to undergo the assessment again using their preferred colors and images.

### **2.3 Statistical Analysis**

The data were analyzed using SPSS software version 25.0. Demographic data and anxiety scores were presented as frequency counts and means  $\pm$  SD. The level of anxiety before and after visualizing the virtual dental clinic in the same student was assessed using a paired t-test. Due to unequal group sizes, differences in levels of anxiety reduction and the duration used to calm participants between groups were determined using the Kruskal-Wallis test followed by Wilcoxon Signed-Rank test. A p-value of less than 0.05 was considered statistically significant.



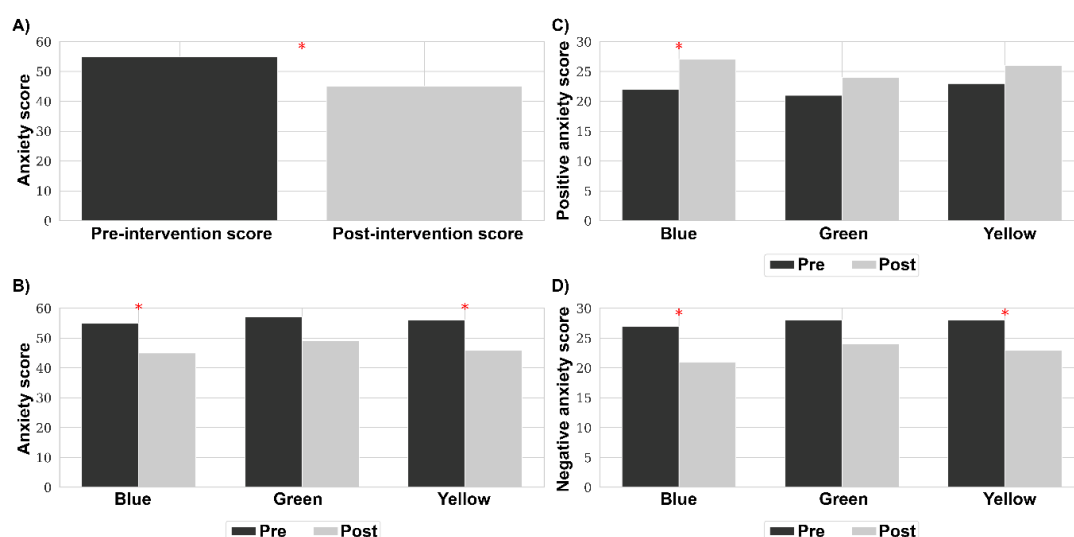
**Figure 1.** Experimental design and equipment. A) Flow chart of experiment. B-D) Phase I: the alteration of the dental clinic wall color including, B) blue (RGB: 153, 222, 255), C) green (RGB: 151, 221, 109), and D) yellow (RGB: 253, 246, 165). E-G) Phase II experiment: the addition of images including, E) mountain image, (Def, 2020). F) sea image, by Author G) nautilus shell image (May, 2019). H) Participant's viewing position I) Example images of the virtual dental clinic with altered wall color. J) Example image of the virtual dental clinic featuring the added image. **Source:** A-D, H-J by Author.

### 3. Results

#### 3.1 Phase I: The Influence of Wall Color of the Dental Clinic in Reducing Anxiety

The results showed that blue was the most frequently selected color ( $n = 26$ ), followed by green ( $n = 5$ ) and yellow ( $n = 4$ ). Overall, when the background color of the dental clinic was altered, the anxiety scores significantly decreased from  $55.17 \pm 7.78$  to  $45.40 \pm 8.74$  ( $p < 0.05$ ) (Figure 2a). Both the blue and yellow colors significantly reduced the anxiety score, from  $54.92 \pm 8.13$  to  $44.46 \pm 9.44$  ( $p < 0.05$ ) and from  $54.50 \pm 5.00$  to  $46.00 \pm 1.83$  ( $p < 0.05$ ), respectively. The green color also lowered the anxiety score, from  $57.00 \pm 8.80$  to  $49.80 \pm 7.79$ ; however, this reduction was not statistically significant (Figure 2b).

Regarding anxiety type, the blue-wall dental clinic significantly increased the positive anxiety (PA) score and decreased the negative anxiety (NA) score ( $p < 0.05$ ). Although the yellow-wall dental clinic increased the PA score and lowered the NA score, statistical significance was observed only for the NA score ( $p < 0.05$ ). The green-wall dental clinic also increased the PA score and decreased the NA score, with statistical significance observed for both scores (Figure 2c).

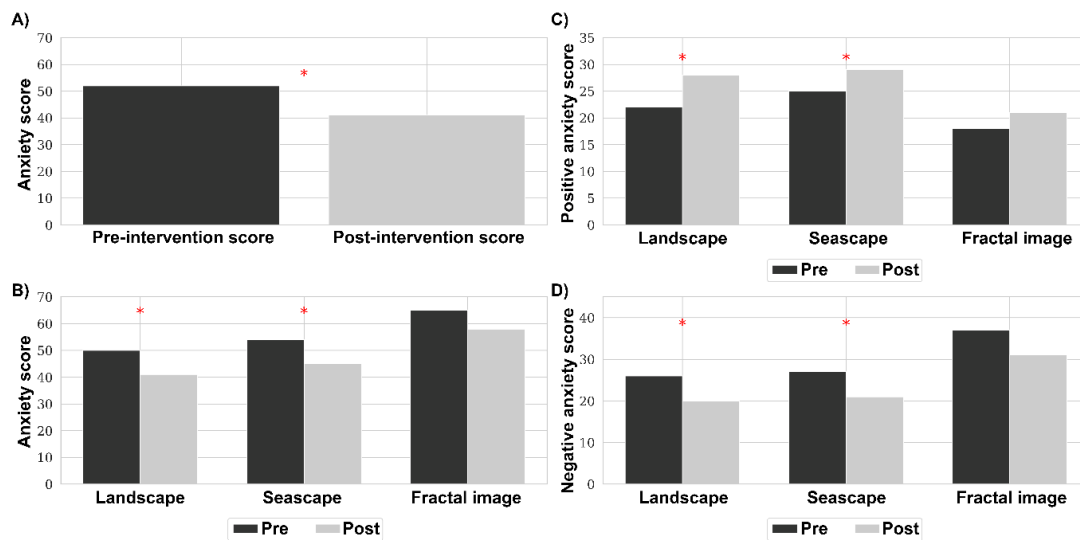


**Figure 2.** The comparison of mean STAY-1 scores before and after visualizing the blue-, green-, and yellow-wall dental clinics. A) Overall, changing the dental clinic wall resulted in a decrease in anxiety scores. B) Only the blue- and yellow-wall dental clinics significantly decreased anxiety scores. C) The blue-wall dental clinic significantly elevated the PA score. D) Both blue- and yellow-wall dental clinics significantly lowered the NA score. ( $N = 35$ ; paired  $t$  test,  $*$  =  $p$ -value  $< 0.05$ ) **Source:** by Author

#### 3.2 Phase II: The Influence of Nature Images on Reducing Anxiety

The results indicated that the mountain image was the most frequently selected ( $n = 21$ ), followed by the sea image ( $n = 13$ ) and the nautilus shell image ( $n = 1$ ). Overall, the anxiety score significantly decreased when either mountain, sea, or nautilus shell image was added to the dental clinic, dropping from  $52.34 \pm 8.85$  to  $41.29 \pm 7.70$  ( $p < 0.05$ ) (Figure 3a). For the mountain image, the anxiety score significantly decreased from  $53.09 \pm 8.01$  to  $41.86 \pm 6.78$  ( $p < 0.05$ ), while the sea image resulted in a decrease in the anxiety score from  $49.77 \pm 9.00$  to  $39.00 \pm 7.68$  ( $p < 0.05$ ). The nautilus shell image also contributed to a reduction in the anxiety score; however, due to only one participant selecting this type of image, statistical analysis could not be conducted (Figure 3b).

Regarding anxiety type, both the mountain and sea images significantly increased in the PA score ( $p < 0.05$ ), as well as decreased in the NA score ( $p < 0.05$ ) (Figure 3c).

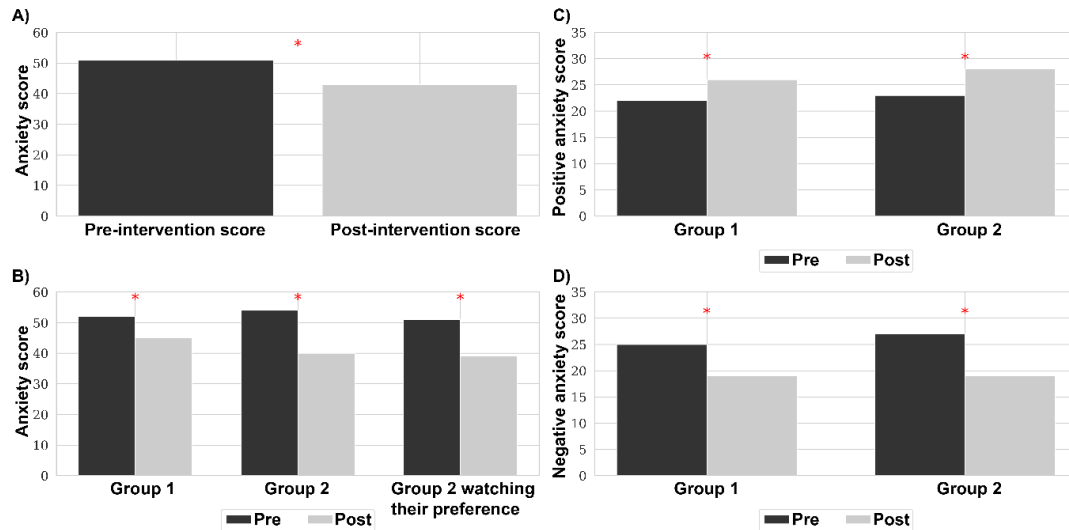


**Figure 3.** The comparison of mean STAY-1 scores before and after visualizing the dental clinic, which added mountain, sea, and nautilus shell images. A) Overall, the addition of either mountain, sea, or nautilus shell images to the dental clinic significantly reduced the anxiety score. B) Both mountain and sea images statistically helped lower the anxiety score. C) Both mountain and sea images provided a significant increase in the PA score. D) Both mountain and sea images significantly decreased in the NA score. (N = 35; paired t test, \* =  $p$ -value  $< 0.05$ ) **Source:** by Author

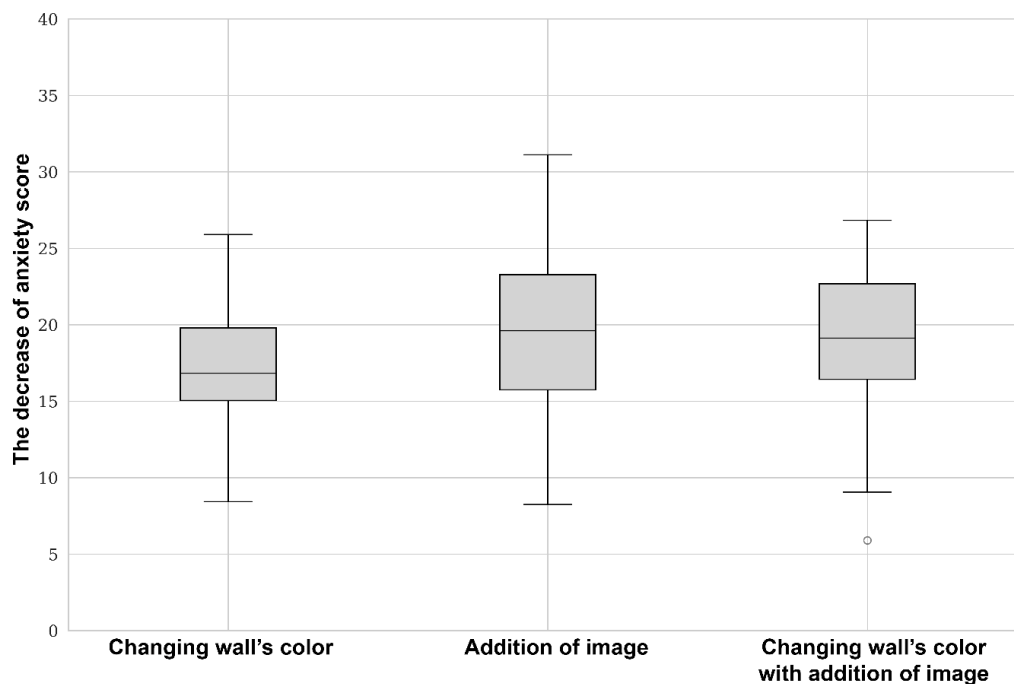
### 3.3 Phase III: The Influence of the Combination of Clinic Wall Color Changing and Images in Reducing Anxiety

Having established that the blue-wall dental clinic and mountain image were the most preferred choices, the study further investigated whether this combination could reduce anxiety. Participants were divided into two groups based on their preferences: group 1 ( $n = 16$ ), whose preferred combination matched the general preference, and group 2 ( $n = 19$ ), whose preferences did not match the general choice (Figure 4a). Overall, visualizing the blue-wall dental clinic with a mountain image reduced anxiety from  $50.82 \pm 9.46$  to  $42.00 \pm 8.55$  ( $p < 0.05$ ). In group 1, anxiety decreased from  $51.44 \pm 10.17$  to  $42.13 \pm 9.70$  ( $p < 0.05$ ), while group 2 experienced a similar reduction from  $50.31 \pm 9.08$  to  $41.89 \pm 7.73$  ( $p < 0.05$ ). When group 2 visualized their preferred combination, anxiety decreased from  $50.31 \pm 9.08$  to  $39.26 \pm 9.23$  ( $p < 0.05$ ). No significant differences were observed between group 1, group 2 visualizing the general preference, and group 2 visualizing their preferred combination (Figure 4b).

In terms of anxiety types, visualizing the blue dental clinic with mountain image significantly increased PA scores and decreased NA scores for both group 1 and group 2 ( $p < 0.05$ ) (Figure 4c). When comparing results across three phases—visualizing the colored-wall dental clinic, the dental clinic with an added image, and the combination of both the colored wall and image—no significant differences were found in the reduction of anxiety scores (Figure 5).



**Figure 4.** The comparison of mean STAY-1 scores before and after visualizing the blue dental clinic with a hanging landscape image. A) Overall, visualizing the blue dental clinic with the hanging mountain image significantly decreased the anxiety score for both groups, regardless of whether this combination matched the participant's preference. B) Anxiety scores in group 1 (matching preferences) and group 2 (non-matching preferences) decreased significantly after visualizing the blue dental clinic with the hanging mountain image. In group 2, scores also decreased significantly when visualizing their preferred combination, with no difference between their preference and the general preference. C&D) The PA score of both experimental groups statistically increased after visualizing the blue dental clinic with the hanging mountain image, while the NA score decreased significantly. (N = 35; paired t test, \* = p-value < 0.05) **Source:** by Author



**Figure 5.** Comparison of the reduction in anxiety scores between three interventions: changing the dental clinic wall's color, the addition of either mountain, sea, or nautilus shell images, and the combination of both changing the dental clinic wall and the addition of an image. No statistically significant difference was noted between the three interventions (N = 35; one-way ANOVA) **Source:** by Author

## 4. Discussion

Clinical dental practice can be very stressful; therefore, several attempts have been made to reduce stress and anxiety for undergraduate dental students, including sound therapy and improvements in interior design. Since perception stimuli have been reported to influence emotional responses (Collier, 1996), the present study aimed to determine the effects of color and images on reducing anxiety in undergraduate dental students.

The results show that soft blue, green, or yellow walls reduced anxiety among undergraduate dental students based on within-subject pre-post comparisons, consistent with previous studies (Annamary et al., 2016; Rafatjou et al., 2021). It is reported that humans can map colors and shapes to feelings, with each color tending to evoke certain connotative adjectives (Collier, 1996). The present study selected soft blue, green, and yellow based on Hettiarachchi & Perera's (2021) study, with the expectation that their universal tendencies related to anxiety and stress reduction would improve studying: blue for its ability to encourage intellectual activity, reasoning, and logic (Wright, 1998); green for a color that conveys a sense of refreshment, harmony, and equilibrium (Eiseman, 2006); and yellow for joy (Eiseman, 2006), self-esteem, and creativity (Wright, 1998).

Although it is widely noted that there may be yellow-happy and blue-sad associations (Schloss et al., 2020), the present study's results show that blue was the most preferred color, followed by green and yellow. This aligns with a study in school children that blue generally is preferred (Annamary et al., 2016). It was reported that children who had never undergone dental treatment experienced lower anxiety levels in clinics where the dentist's attire and the curtains were blue and pink. These groups also showed lower pulse rates and higher SpO2 levels compared to participants attending the other-color-environment clinic (Rafatjou et al., 2021). Earlier research has mapped a relationship between blue and sad feelings; this may be due to the term 'blue' in English having another meaning, feeling blue, which may cause viewing this color to evoke feelings of sadness. On the contrary, previous studies, including the present one, demonstrate that blue can have a positive effect on emotions, similar to yellow (Annamary et al., 2016) and that the association of sadness with blue and gray is weak (Schloss et al., 2020). This may be explained by the principles of color composition. It is reported that colors tend to be rated as happier when they are lighter, more vibrant, and bluer. The perception that yellow is happier than blue likely stems from differences in lightness rather than hue; yellow has the greatest potential to evoke happiness because it maximizes both lightness and chroma (Schloss et al., 2020). Consistent with Schloss's study, the present study utilized soft shades of blue, green, and yellow, with lightness values of 80%, 67%, and 85%, respectively. These values are relatively high, which may explain why no statistical difference in the ability to reduce anxiety was observed between blue and yellow. Interestingly, there were two methods to reduce anxiety: increasing the PA score and/or decreasing the NA score. According to the study, although blue and yellow colors could reduce anxiety scores, they did so in different ways. Blue reduced anxiety by both increasing the PA score and decreasing the NA score, while yellow only reduced the NA score. This finding differed from previous studies, which suggested that seeing the color yellow increased happiness (Wright, 1998; Eiseman, 2006; Schloss et al., 2020). This difference may have been because looking at a dental clinic triggered negative emotions. Therefore, the initial effect of changing the room color likely targeted the prominent feeling.

Guided imagery can be an effective intervention for anxiety, as it induces relaxing states through mental processes (Nguyen & Brymer, 2018). The present study shows that three types of images could reduce anxiety in dental students, with the preferred images being mountain, sea, and nautilus shell, respectively. The preference for mountain and sea images over nautilus shell image can be explained by visual composition: the former

provided greater viewing distances and openness, which may reduce feelings of constraint and thus decrease anxiety. A previous study reported that greater openness is associated with stronger restorative effects on emotion (Shu et al., 2022). Although not the most frequently chosen, the sea image had a statistically significant effect in reducing anxiety. This can be explained by two reasons: firstly, the sea image has a higher proportion of blue than the others; therefore, the effect of blue may influence as previously discussed. Secondly, the sea image is a reminder of water, which has the potential to reduce stress. Touching, hearing (Çulha et al., 2023), or even just watching the water (Ulrich, 1981) provides a high sense of relaxation. Previous research shows that nature, particularly water environments, significantly reduced negative emotions like sadness and fear-arousal when compared to urban scenes or scenes without water (Ulrich, 1981). Moreover, since viewing mountain and sea images immediately reminded participants of nature, it was unsurprising that these images contributed to both an increase in PA scores and a decrease in NA scores.

Although the effectiveness of viewing fractal images in reducing anxiety remains a topic of debate, several studies reported their potential to alleviate anxiety (Hagerhall et al., 2008; Simion, 2015). A previous study revealed that participants who engaged in 30 hours of fractal-based meditation experienced a significant reduction in anxiety and stress, except for one individual with emotional suppression (Simion, 2015). Additionally, mid-range complexity fractals in classrooms and therapy offices were suggested to create a calming environment and serve as a tool for psychological exploration (Salingaros & Xie, 2012). Furthermore, fractals with dimensions between  $D\ 1.3$  and  $D\ 1.5$  were found to activate alpha brain waves, which are associated with relaxation and inward focus (Hagerhall et al., 2008). However, in the present study, only a small number of participants selected the nautilus shell image, possibly because natural fractal images typically consist of close-up representations of elements in nature, such as the patterns of seashells or the petals of cacti. Viewing such zoomed-in images might have diminished their stress-reducing effectiveness, as they could not compensate for the reduced openness. Moreover, while fractal geometry images represented repetitive patterns found in nature, they might have required multiple levels of interpretation before being associated with elements of nature. Nonetheless, participants who viewed a dental clinic with the nautilus shell image also exhibited reduced anxiety scores. However, as only one participant selected this image, statistical determination was not feasible. Therefore, the effectiveness of such images in promoting relaxation remains substantiated.

When combining the most preferred color and image, the results demonstrated that a blue clinic paired with mountain image significantly reduced anxiety levels in both those who chose and did not choose this combination. This finding suggests that specific elements of color and nature images may inherently contribute to anxiety reduction, regardless of personal preferences. These results emphasize the complex interplay between individual expectations, social dynamics, and the psychological impact of visual stimuli on anxiety.

When comparing the three experiments, although no significant differences were noted in the reduction of anxiety levels from changing the room color, adding images, or both changing the color and adding images, it was observed that adding images resulted in the greatest reduction in anxiety. This was followed by changing the room color, with the combination of both color change and image addition yielding the least reduction in anxiety. The lesser reduction in anxiety with color change alone may be attributed to the fact that relaxation processes related to anxiety reduction primarily derive from direct exposure to nature. Viewing nature images may evoke a stronger reminder of nature than altering room colors, as hues represent merely one component of an image. In reality, nature encompasses a broader range of colors and shades, suggesting that a diverse color palette may yield greater anxiety-reducing effects than using a single color. Meanwhile, changing both

the color and the image may have caused cognitive overload because it could have made people focus on too many things at once. This made it harder to focus on any one aspect, negatively impacting emotional regulation. Higher cognitive demands can reduce emotional control, leading to poorer emotional responses (Brockbank & Feldon, 2024). Additionally, combining these elements may evoke conflicting emotions or associations, particularly if the colors or images do not harmonize, resulting in increased anxiety instead of the desired calming effect. Regarding dental practice, students often worry in advance about what may happen next. Therefore, having a focal point, such as an image, might help distract from anxiety more effectively. Furthermore, nature images require less interpretation, which could be a reason they were more effective in reducing stress compared to other methods. This conclusion suggests that, when considering cost-effectiveness, adding nature images may be the most cost-effective method.

The limitation of the present study is that it serves as preliminary research focused on identifying methods to reduce dental student anxiety. Only colors and images that are likely to evoke positive emotions were selected as the intervention. Therefore, neither white nor any colors reported to be associated with stress were included as controls and negative controls, respectively. Furthermore, this study did not determine the effect of specific color components such as hue, lightness, and saturation, nor did it consider elements of the images like mountain type, openness, or viewing distance. As a result, it may not be possible to specify which particular components of the selected colors and images primarily contributed to anxiety reduction. To fully benefit, additional studies that focus on adapting these elements to fit each circumstance are necessary, as the effectiveness of color and image selection in reducing anxiety is likely to be influenced by the specific context. Environmental color and image are integral components of architectural space that influence psychological well-being, particularly in high-stress educational healthcare environments. While architectural structural modifications often require substantial financial investment, environmental color and image can still exert meaningful psychological effects. In this regard, VR may serve as a practical alternative to support decision-making before implementing permanent design changes. However, this study relied on VR images, which may differ from real physical environments in sensory experience; therefore, the findings may not fully represent anxiety responses in real-world settings. Future studies should incorporate real images alongside VR stimuli, especially when image elements are selected based on students' preferences.

## 5. Conclusion

Color tones and visual images in clinical settings were demonstrated to have a positive influence on anxiety levels in dentistry students. Changing the wall color of a dental clinic, adding either mountain, sea, or nautilus shell images, or combining both can affect dental students' anxiety levels. While individual design preferences may vary, the majority of preferred design choices in clinical environments have the potential to universally reduce anxiety. This study highlights the importance of creating a supportive educational environment, which could potentially lead to improved learning outcomes and decreased anxiety in high-pressure settings.

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## Human Subjects

All participants provided written informed consent prior to their inclusion in the study. Participation was voluntary and participants could withdraw at any time without penalty.

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## Data Availability Statement

Data is available from the corresponding author upon reasonable request, subject to privacy restrictions.

## Use of Generative Artificial Intelligence (AI) and AI-Assisted Technologies

During the preparation of this manuscript, Claude AI was used for language editing and proofreading purposes. Whereas, all scientific content, data analysis, and conclusions were developed entirely by the authors.

## Author Contributions

**Adjabhak Wongviriya:** Conceptualization, Methodology, Writing – Original Draft, Writing – Review & Editing. **Athikun Viwallong:** Data Curation. **Pichayapa Tangjongrach:** Data Curation. **Suphichaya Kongteerapat:** Data Curation. **Ariya Chantaramanee:** Formal Analysis. Supaporn Sangouam: Writing – Review & Editing. **Thanasarn Changnawa:** Conceptualization, Methodology, Software, Writing – Review & Editing. **Sasitharee Nathamtong:** Conceptualization, Methodology, Data Curation, Writing – Review & Editing, Supervision.

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