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**Original Article**

# Evaluating the Impact of Various Teaching Approaches on Dental Students' Accuracy in Tooth Shade Selection

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## ABSTRACT

Achieving an accurate match between tooth color and restorations is the most challenging aspect of restorative dentistry. The process of teaching and learning color matching is an important component of dental education. This study aimed to investigate the effect of different instructional methods on dental students' ability to determine tooth color. Participants were randomly divided into two groups: one group received face-to-face, hands-on training on color-matching techniques, while the other group used a self-guided learning booklet. Each student was asked to identify the color of selected samples using the Vita Classic shade guide before training, immediately after training, and one month later. The accuracy of color selection was analyzed using the Pearson chi-square test, with a sample size of 18 to 20 and a 95% confidence level. The results showed that students who used the training booklet performed significantly better in identifying the fourth sample ($P < 0.01$). However, in both groups, the color selection accuracy did not surpass pre-training results one month after training. Furthermore, no significant correlation was found between students' gender, use of glasses, and their ability to determine color accurately. These findings suggest that a booklet-based educational approach may be better and more efficient than practical training in enhancing dental students' proficiency in tooth color matching.

**Keywords:** Tooth color, Dental students, Educational methods, Color determination

## Introduction

In modern dentistry, aesthetics play a crucial role in treatment, making it an essential aspect of dental care. As societal awareness and cultural standards evolve, individuals are becoming increasingly concerned with the appearance of their teeth. Achieving a natural and aesthetically pleasing restoration requires not only technical expertise but also an artistic approach. Factors such as tooth shape, symmetry, proportion, color, translucency, and harmony with surrounding teeth and facial features must all be carefully considered to ensure optimal results [1, 2].

Color science is a fundamental component in achieving successful aesthetic outcomes, making it a critical aspect of restorative and prosthetic dentistry [3-5]. Even if all other artistic and technical factors are perfectly executed, an incorrect color selection can compromise the outcome. A mismatch in tooth color can lead to additional costs for corrections or replacements, dissatisfaction among patients, and potential professional setbacks for dentists [6].

Tooth color can be determined either through visual assessment or with the aid of specialized instruments. The visual method typically relies on shade guides, while more advanced tools such as spectrophotometers and

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colorimeters offer precise color measurements [7-9]. Proper training in color determination techniques is essential to ensuring accurate shade selection and enhancing the overall success of dental restorations.

Research has indicated that color perception varies among individuals, with factors such as gender potentially influencing color selection. However, studies on this topic have produced conflicting results. Additionally, differences in lighting conditions and sources of color can lead to variations in color determination outcomes [10, 11]. The concept of color is highly intricate, relying on a combination of physical stimuli, the interaction of psychophysical signals between the stimulus and the eye's receptor cells, and the brain's interpretation of the received information. Any alteration in these elements—stimulus, receptor, or cognitive processing—can lead to inaccurate color perception [12, 13].

Given that color matching is largely perceptual, achieving accuracy in color selection requires an understanding of fundamental color principles, proper training, and hands-on clinical experience. Consequently, color determination is a vital component of dental education. However, the precise impact of training on enhancing the ability to visually assess color remains uncertain [14, 15]. This study aims to evaluate and compare the effectiveness of two distinct educational approaches in improving dental students' ability to determine tooth color, and to identify the most beneficial method for enhancing their training.

## Materials and Methods

This prospective interventional study determined the sample size using values of $\alpha < 0.01$ and $\beta < 0.0$, assigning 40 participants to each group. The students were randomly divided into 2 groups using a random number table. The first group received in-person training on tooth color-matching techniques, while the second group was taught through an educational booklet. The study variables included the two different instructional methods, the participants' gender, and their history of wearing prescription glasses.

For the first group, face-to-face training consisted of attending lectures conducted by a professor on color selection principles and observing demonstrations of color determination at the patient's bedside. In contrast, the second group received all instructional materials in written form through pamphlets, without attending live lectures or clinical demonstrations.



The study utilized the Vita Classic color determination series, selecting B4, D4, A2, and C2 color samples while concealing their corresponding color codes. Participants from both groups were asked to identify the color of these samples before training, immediately after training, and again one month later using a complete Vita shade guide. Their responses were recorded in structured questionnaires.

Color identification accuracy was evaluated on two levels: first, determining the correct hue (A, B, C, or D), and second, identifying the precise chroma number for each shade. Given the nature of the collected data, statistical analysis was performed using the Pearson Chi-Square test.

## Results and Discussion

In this study, the majority of participants reported no prior history of wearing prescription glasses. Additionally, 57.89% of the total participants were female. Statistical analysis using Fisher's Exact test indicated no difference between the two groups concerning gender distribution and previous use of glasses ($P > 0.05$) **(Table 1)**.

**Table 1.** The ability to determine the color

| Group | Gender | | History of using glasses | | Total (%) |
|---|---|---|---|---|---|
| | Female (%) | Male (%) | Positive (%) | Negative (%) | |
| Booklet training | 9 (23.68%) | 11 (28.95%) | 10 (26.32%) | 10 (26.32%) | 20 (52.63%) |
| Practical training | 13 (34.23%) | 5 (13.16%) | 7 (18.42%) | 11 (28.95%) | 18 (47.27%) |
| Total | 22 (57.89%) | 16 (42.11%) | 17 (44.74%) | 21 (55.26%) | 38 (100%) |
| The result | P = 0.112 | | P = 0.532 | | |

The findings revealed no differences between practical training and booklet-based instruction in enhancing students' ability to determine tooth color. The type of training received did not significantly impact the accuracy of identifying the first (B4), second (D4), or third (A2) color samples ($P > 0.05$). However, students who received

training through booklets demonstrated significantly better performance in identifying the fourth sample (C2) (P = 0.003).

Notably, in both training groups, the color determination accuracy did not improve one month after the training compared to pre-training results. Additionally, no significant correlation was observed between gender or the use of glasses and the accuracy of color identification (P > 0.05). The only exception was in the 2nd color sample (D4), where female participants showed significantly better results (P = 0.036).

Overall, both training approaches proved beneficial for color determination, with no significant difference in accuracy across the 4 samples, except for the fourth (C2), where booklet-based instruction led to better results. However, in all cases, accuracy declined after one month.

The results showed that neither gender nor the use of prescription glasses had a significant impact on the ability to choose tooth color. Both male and female participants, as well as those wearing glasses and those without, performed equally in identifying the color samples.

This study aimed to assess and compare the effectiveness of two educational methods—practical training and training using a handbook—on students' ability to determine tooth color, both before and immediately after the training, as well as one month later, while considering gender and glasses usage history.

In dentistry, visual color selection remains the most commonly used method for color matching [12, 14, 16-18]. The process involves visual evaluation using color guides, with well-established principles for accurate selection [19]. The most widely used tool for clinical color selection is the Vita Shade Guide [20].

Even though there are various tools designed to enhance the success of clinical color matching, visual selection continues to be a standard practice, despite its subjectivity and variability. This can be influenced by factors such as age, gender, experience, visual impairments, training, and eye fatigue [19]. Given the potential effect of gender on the perception of tooth color, this study explored the role of gender differences in determining color. While many studies have investigated the impact of gender on color-determination ability, there is no consensus in the literature on this matter [21].

The findings of this study indicated that, except for the booklet-trained group for the 2nd color sample, there were no significant gender-based differences in the accuracy of color determination across other groups. For the 2nd color sample, taken from the Vita classic color guide series (sample C2), 59.26% of women in the booklet group correctly identified the color, whereas only 30% of men achieved the same result, showing a significant difference (P = 0.036). Although women in the practical training group performed better than men, the difference was not statistically significant.



These results align with those of Nakhaei *et al*. [22], who found no gender-based differences in the ability to distinguish between colors in the Vita series. Similarly, studies by Curd *et al*. [23] showed that dental students demonstrated no significant gender differences in their ability to select tooth color. In Daneshkazemi *et al*. study [24], no significant difference was found in the ability of men and women to correctly identify the colors in the test. Some studies have suggested that women tend to have better color perception, particularly in the red and green spectrums, while men may excel at perceiving darkness and brightness [25].

Carsten proposed that individuals with poor color selection abilities might have color vision deficiencies, which affect a certain degree of the male population, either temporarily or permanently, resulting in color vision confusion [26]. According to genetic inheritance patterns related to the retinal color-sensitive cells, females are generally thought to have superior color vision compared to males [3]. Moreover, Haddad *et al*. [27] also concluded that women generally perform better in color selection tasks compared to men.

In contrast to our findings, Gharemanloo *et al*. [28] observed that when using both color guide systems male students demonstrated a higher repeatability rate compared to female students. However, this difference was not significant and warrants further investigation. In our study, while a significant proportion of students were able to correctly identify the color samples, no notable effect was observed from either practical training or the use of the pamphlet. The findings did not follow a consistent trend across different color samples. For instance, in the first sample (B4), a high percentage of participants accurately identified the color at the start of the study. However, this percentage decreased after pamphlet training and one month following practical training, despite an initial improvement.

An intriguing result of our study was that, across all groups and color samples, the results 1 month after training did not surpass the initial pre-training results. This suggests that although some improvements in correct color determination were observed shortly after training, these gains did not persist over time.

In this study, a comparison was made between two teaching methods: pamphlet-based instruction and practical training. Even though the pamphlet group showed better results in all the color samples, a statistically significant difference was only observed for the 4th color sample (C2). No significant differences were found in the other samples. While no previous studies have directly compared these two methods, it is plausible that the pamphlet method's advantage comes from the possibility of revisiting the material. This contrasts with face-to-face practical training, where students might be less engaged or patient. Thus, pamphlet-based teaching may be a more efficient approach for dental students, especially considering the challenges associated with in-person training.

Alfouzan *et al*. highlighted that training and practice in color selection are crucial for improving accuracy in color determination. Similarly, Gharemanloo *et al*. [28] suggested that clinicians have a better grasp of color selection techniques than students, and students, in turn, outperform nurses. This underscores the importance of additional training sessions to enhance proficiency in this area.

In this study, the impact of a history of using glasses on color determination ability was also examined. Although individuals without glasses performed better on the 1st color sample (D4), those who wore glasses generally performed better in the remaining samples. However, no significant differences were found across any of the color samples ($P > 0.05$). These results may indicate that many individuals experience mild vision issues without realizing it, possibly because these issues do not significantly affect their daily activities or work tasks.

## Conclusion

The findings of this study suggest that training using pamphlets plays a more significant role in enhancing color determination accuracy than practical training for dental students. Additionally, factors such as the use of glasses and gender never affect the ability to determine the color of the samples in the study. However, some limitations should be considered, including the lack of assessment of experience as a factor influencing color determination accuracy, the omission of other potential educational methods, and the fact that the study was conducted in vitro. Future research could address these aspects to gain a more comprehensive understanding of color determination proficiency.



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