Perceptual Dynamics of Peri-Implant Pink and White Tissue Esthetics: A Cross-Sectional, Questionnaire-Based Analysis Among Dental Students

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ABSTRACT

Background:

Achieving esthetic excellence in implant dentistry requires the harmonious integration of periimplant soft tissue contours (pink esthetics) and prosthetic crown morphology (white esthetics). Understanding dental students' perceptions of these parameters is essential, as they are the future providers of implant therapy.

This study aims to assess dental students' awareness and perception of pink and white esthetics in implant-supported restorations

Methods:

A cross-sectional online survey was conducted among 151 dental students using a validated 25-item questionnaire evaluating knowledge of esthetic concepts, indices such as the Pink Esthetic Score (PES) and White Esthetic Score (WES), and the role of digital tools. Data were statistically analyzed using SPSS, and Chi-square tests were applied with significance set at $p < 0.05$.

Results:

Of the 151 dental students surveyed, 91.4% reported prior exposure to implant procedures, indicating strong foundational awareness. Knowledge of esthetic parameters was high, with 84.1% recognizing pink esthetics and 85.4% acknowledging white esthetics as essential for implant success. A total of 89.4% were familiar with the Pink Esthetic Score and 82.8% with the White Esthetic Score. Key factors identified included gingival biotype (89.4%), gummy smile management (80.1%), and soft-tissue contour (63.6%). Additionally, 69.5% preferred case-based clinical learning, while 88.1% endorsed Digital Smile Design as enhancing diagnostic predictability. All associations were statistically significant ($p < 0.05$).

Conclusion:

Dental students demonstrated strong theoretical understanding of esthetic concepts in implant prosthodontics; however, limited clinical exposure highlights the need for enhanced experiential training. Incorporating digital technologies, simulation-based learning, and esthetic workshops into the curriculum may significantly improve clinical competency and contribute to superior esthetic outcomes in implant dentistry.

Keywords: Pink esthetics, White esthetics, Implant smiles, PES/WES, Digital Smile Design, Dental education.

INTRODUCTION

Over the past few decades, implant dentistry has transitioned from a discipline primarily concerned with osseointegration and functional rehabilitation to one that equally prioritizes esthetic excellence, biomimetic restoration, and patient-centered outcomes. Contemporary patients increasingly demand implant restorations that are imperceptible from natural dentition, both in static and dynamic esthetic zones, thereby elevating the importance of soft- and hardtissue integration in clinical success criteria (Buser et al., 2017; Belser et al., 2009). This paradigm shift necessitates not only surgical precision and prosthetic accuracy but also an indepth understanding of the biological and visual determinants of esthetics.

The esthetic success of implant therapy is determined predominantly through the harmonious interplay of pink and white esthetic parameters. Pink esthetics encompasses peri-implant gingival architecture,

contour, tissue volume, papillary fill, and mucosal thickness, all of which influence the emergence profile and visual continuity with adjacent dentition (Fürhauser et al., 2005). A thin periodontal biotype is more susceptible to soft-tissue recession and translucency of implant components, whereas a thick biotype promotes long-term stability and enhanced esthetic predictability (Hwang & Wang, 2006). In contrast, white esthetics refers to the anatomical form, shade, translucency, surface texture, proportion, and optical properties of the prosthetic crown. Even subtle discrepancies in these parameters may disrupt anterior esthetic harmony, leading to patient dissatisfaction despite functional success (Chu et al., 2017; Goodacre et al., 2018).

To objectively evaluate esthetic outcomes and minimize subjective bias, standardized indices such as the Pink Esthetic Score (PES) and White Esthetic Score (WES) were developed, enabling reproducible clinical assessment and benchmarking across studies (Fürhauser et al., 2005; Belser et al., 2009). These indices have transformed esthetic implantology into an evidence-based discipline by allowing systematic comparison of soft tissue morphology and prosthetic integration.

Concurrently, digital innovations such as Digital Smile Design (DSD), computer-aided design/manufacturing (CAD/CAM), and virtual implant planning software have revolutionized diagnostic accuracy, treatment visualization, and interdisciplinary communication (Coachman & Calamita, 2012; Lin et al., 2018). Digital workflows not only enhance treatment predictability but also facilitate a patient-driven approach, thereby integrating esthetic expectations into clinical decision-making and implant positioning (Joda et al., 2017).

Within this evolving paradigm, dental education holds a pivotal role in shaping the esthetic competence of future clinicians. While theoretical instruction in implant dentistry is widely incorporated into undergraduate and postgraduate curricula, numerous studies indicate a gap in students' ability to critically evaluate esthetic determinants and integrate clinical parameters such as gingival biotype, papillary contour, and crown morphology into treatment planning (Tettamanti et al., 2017; Chugh et al., 2020). Furthermore, limited exposure to digital esthetic tools and objective scoring systems may impede the development of esthetic diagnostic skills required in contemporary implantology.

Given the increasing shift from conventional prosthodontic rehabilitation to digitally driven, esthetically oriented implant therapy, it becomes imperative to assess the awareness and perception of dental students regarding pink and white esthetic principles. Understanding their level of knowledge, clinical interpretation skills, and readiness to adopt digital workflows will not only identify pedagogical gaps but will also guide the development of advanced, competency-based teaching frameworks.

Therefore, the present study aims to evaluate the awareness, perception, and educational preparedness of dental students with respect to pink and white esthetics in implant dentistry, with a focus on their understanding of PES/WES indices, esthetic determinants, and digital treatment planning modalities. The outcomes of this investigation are expected to offer valuable insights for curriculum enhancement and

contribute toward training a new generation of clinicians proficient in both functional and esthetic excellence.

MATERIALS AND METHODS

Study Design and Duration

A cross-sectional, questionnaire-based observational survey was conducted over a one-month period from 29 August 2025 to 29 September 2025 to assess the perception and awareness of esthetic determinants in implant dentistry among dental students. The study, titled *"The Esthetic Eye: Dental Students' Perception of Pink and White Esthetics in Implant Smiles,"* was designed to quantitatively evaluate esthetic literacy, diagnostic interpretation, and educational preparedness in relation to soft- and hard-tissue implant esthetics.

Study Population

The study population comprised undergraduate and postgraduate dental students enrolled at the institution. Participants were selected using convenience sampling, and eligibility required current academic enrollment and willingness to participate. No identifying personal data were collected, thereby maintaining complete anonymity.

Survey Instrument Development

Data were collected using a structured, self-administered questionnaire created via Google Forms. The final instrument consisted of 25 multiple-choice items designed to evaluate the following domains:

1. Demographics and Academic Level – Age, gender, and current year of study.
2. Exposure to Implant Procedures – Prior observational, assistive, or clinical experience with implant placement or restoration.
3. Knowledge of Pink and White Esthetics – Awareness of peri-implant soft-tissue parameters (gingival biotype, papillary architecture), prosthetic determinants (crown morphology, shade matching), and familiarity with objective evaluation indices such as the Pink Esthetic Score (PES) and White Esthetic Score (WES).
4. Perception of Esthetic Determinants – Assessment of student perspectives on critical esthetic variables including smile line, soft-tissue contour, biotype, and patient-related esthetic expectations.
5. Educational Preferences and Digital Integration – Evaluation of learning preferences (traditional lectures vs. case-based and clinical workshops) and use of digital technologies such as Digital Smile Design (DSD).

Validation of the Questionnaire

The questionnaire underwent content validation by a panel of subject-matter experts in Periodontology to ensure construct validity, face validity, and internal consistency. Minor revisions were implemented to optimize linguistic clarity, eliminate ambiguity, and enhance the instrument's cognitive relevance.

Ethical Considerations and Informed Consent

Participation was entirely voluntary. A detailed informed consent statement was embedded within the introductory section of the online form, outlining the study's objectives, anonymity safeguards, and the right to withdraw without penalty. Respondents were permitted to proceed only after actively selecting the "I agree to participate" option, in alignment with institutional ethical standards and the Declaration of Helsinki (2013 revision).

Statistical Analysis

All responses were automatically compiled through Google Forms and exported to Microsoft Excel for preliminary tabulation. Subsequently, the data were subjected to descriptive and inferential statistical analysis using appropriate software tools. Frequency distributions and percentage analyses were employed to evaluate awareness levels, while intergroup comparisons were conducted using relevant statistical tests (e.g., Chi-square test), with $p < 0.05$ considered statistically significant.

RESULTS

A total of 151 dental students participated in the study, encompassing all academic years from first year to internship, thereby ensuring comprehensive representation across varying stages of dental education. The sample demonstrated a slight female predominance (57%), and the inclusion of senior students and interns constituting over half of the cohort reflected substantial clinical exposure within the study population.

Exposure to implant dentistry was remarkably high, with 91.4% of respondents reporting prior clinical observation or assistance in implant procedures. Although participation in hands-on surgical execution was limited, particularly among junior students, theoretical and observational exposure was widespread. Awareness of esthetic concepts demonstrated a strong theoretical foundation, with 84.1% of participants reporting familiarity with pink esthetics and 85.4% with white esthetics. Furthermore, recognition of objective esthetic indices was substantial, as 89.4% identified the Pink Esthetic Score (PES) and 82.8% acknowledged the White Esthetic Score (WES), with 83.5% correctly understanding their significance in standardizing clinical assessment.
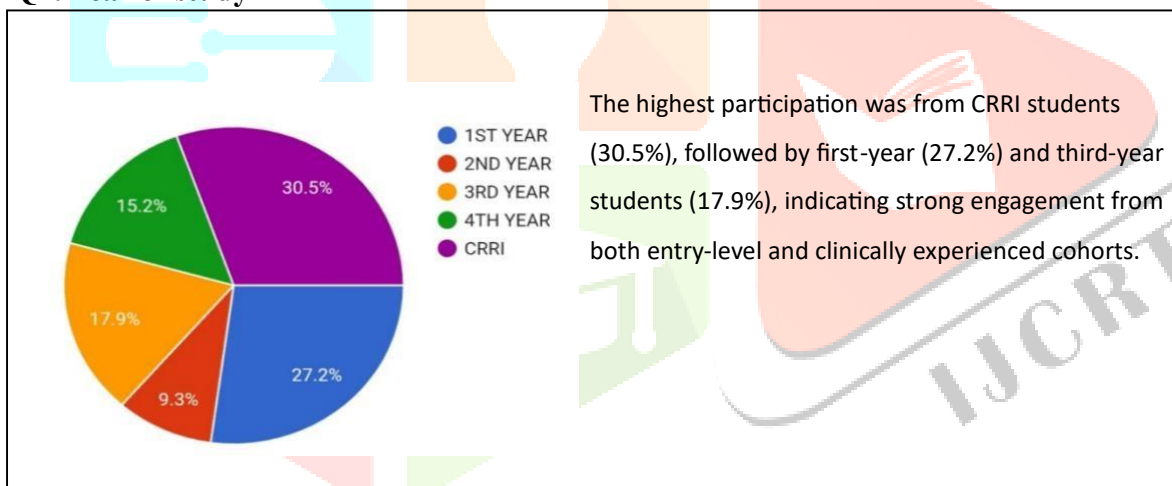
The perception of critical esthetic determinants was notably robust. A high proportion of respondents identified gingival biotype, soft-tissue contour, and excessive gingival display ("gummy smile") as pivotal variables influencing peri-implant esthetic outcomes. Additionally, students demonstrated an appreciation

of prosthodontic parameters, including crown morphology, shade selection, and the strategic use of soft-tissue augmentation, in achieving optimal esthetic integration.
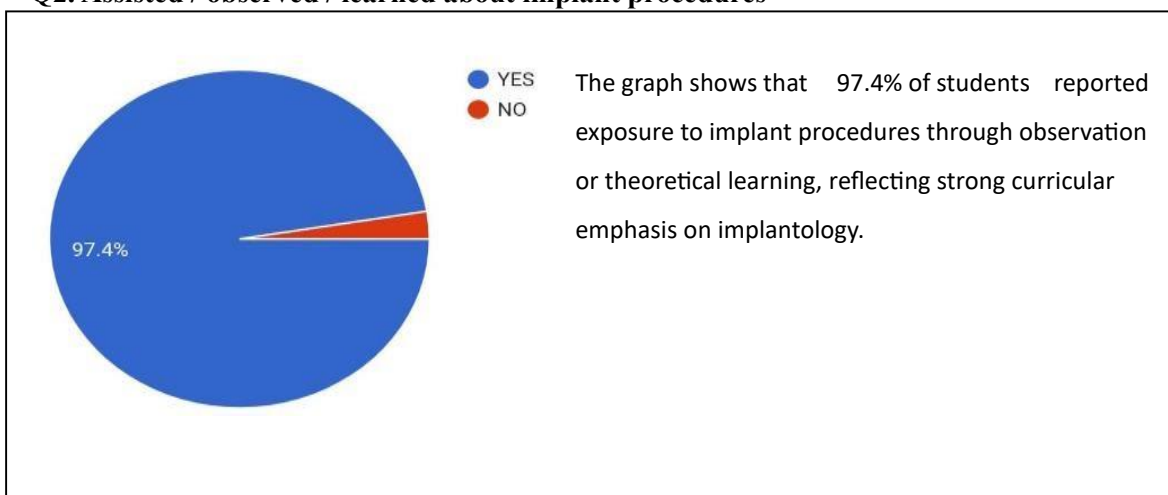
With respect to pedagogical preferences, approximately 69.5% of respondents expressed a preference for experiential and interactive learning modalities such as case-based discussions and clinical workshops over traditional didactic formats, illustrating a shift toward applied and clinically immersive education. Digital technologies were overwhelmingly endorsed, with 88.1% recognizing Digital Smile Design (DSD) as a valuable tool for enhancing diagnostic accuracy and treatment predictability, while 83.1% supported the use of digital photography in esthetic assessment. Moreover, 85.4% acknowledged the importance of incorporating patientcentered esthetic expectations during treatment planning.
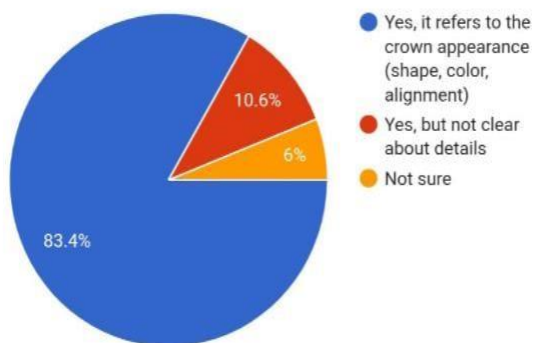
Chi-square analyses revealed statistically significant associations ($p < 0.05$) between academic level and exposure to implant procedures, awareness of esthetic concepts, and preference for advanced educational tools. Senior students consistently demonstrated superior knowledge and heightened clinical acumen compared to their junior counterparts, underscoring the influential role of progressive clinical exposure in enhancing esthetic competence.
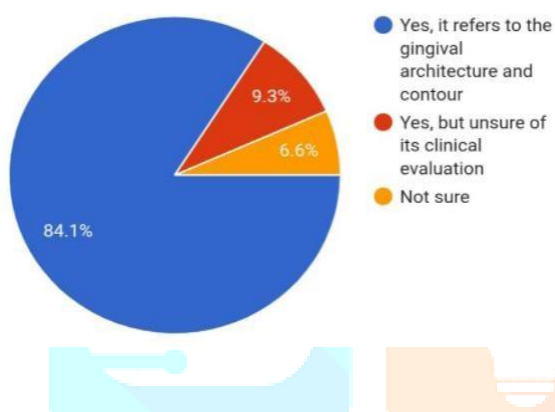
Q1. Year of study

The highest participation was from CRRI students (30.5%), followed by first-year (27.2%) and third-year students (17.9%), indicating strong engagement from both entry-level and clinically experienced cohorts.

Q2. Assisted / observed / learned about implant procedures

The graph shows that 97.4% of students reported exposure to implant procedures through observation or theoretical learning, reflecting strong curricular emphasis on implantology.

Q3. Familiarity with "White esthetic"

- Yes, it refers to the crown appearance (shape, color, alignment)
- Yes, but not clear about details
- Not sure

10.6%

6%

83.4%

A significant majority (83.4%) of students demonstrated clear understanding of the term "white esthetics," indicating strong theoretical knowledge of crown-related esthetic parameters. However, 16.6% showed uncertainty or incomplete understanding, emphasizing the need for enhanced conceptual clarity in the curriculum.

Q4. Familiarity with "Pink esthetics"

- Yes, it refers to the gingival architecture and contour
- Yes, but unsure of its clinical evaluation
- Not sure

9.3%

6.6%

84.1%

A substantial majority (84.1%) of respondents demonstrated awareness of the concept of "pink esthetics," indicating strong recognition of gingival architecture and contour as key esthetic determinants, while 15.9% showed uncertainty, highlighting the need for improved clinical emphasis on soft tissue evaluation in implant training

Q5. Knowledge of Pink Esthetic Score (PES)

- Gingival form and papilla
- Crown shade
- Bone level
- Not sure

6.6%

88.7%
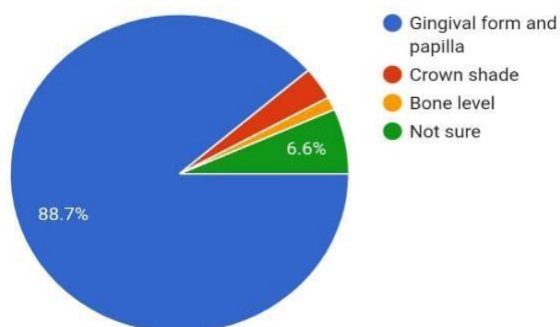
The majority of respondents (88.7%) accurately identified that the Pink Esthetic Score evaluates gingival form and papilla, demonstrating strong conceptual understanding of soft-tissue esthetic parameters, while a minimal proportion (11.3%) showed misinterpretation or uncertainty.

**Q6. Knowledge of White Esthetic Score (WES)**
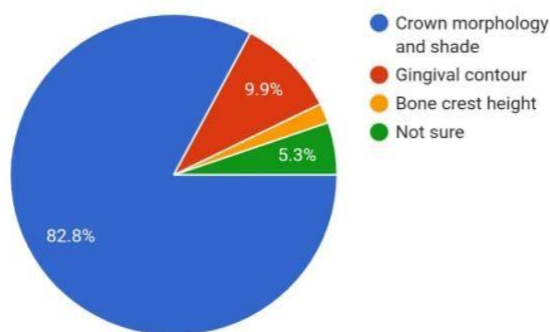
A large majority (82.8%) correctly identified that the White Esthetic Score evaluates crown morphology and shade, indicating strong awareness of prosthetic esthetic criteria, while 17.2% demonstrated confusion regarding its clinical application, highlighting minor gaps in advanced esthetic comprehension.

Q7. Reason for PES/WES system introduction
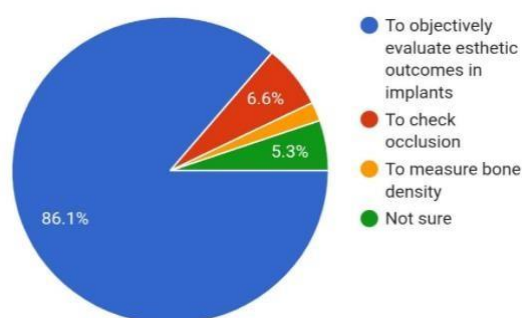
Most respondents (≈83.5%) correctly stated that PES/WES were introduced to standardize esthetic assessment and provide objective outcome measures. This awareness reflects understanding of evidence-based esthetic evaluation, supporting objective reporting in implant smile research and clinical audits.

**Q8. Influence of gingival biotype on esthetic outcome**
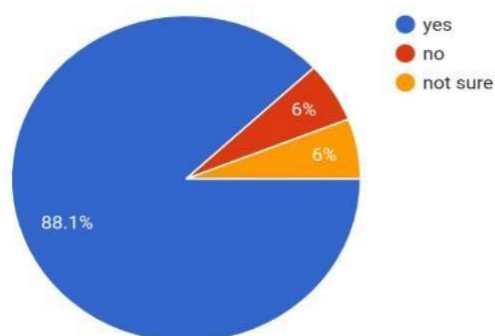
A strong majority (≈89.4%) agreed gingival biotype affects esthetic results. This demonstrates good clinical awareness that thin biotypes are prone to recession and that thick biotypes may mask contour discrepancies essential knowledge for planning implant placement and soft -tissue augmentation.

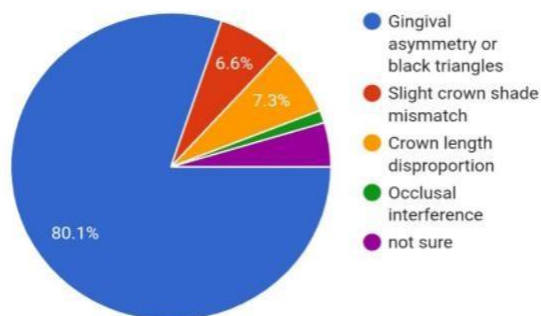## Q9. Gummy smile and esthetic challenges
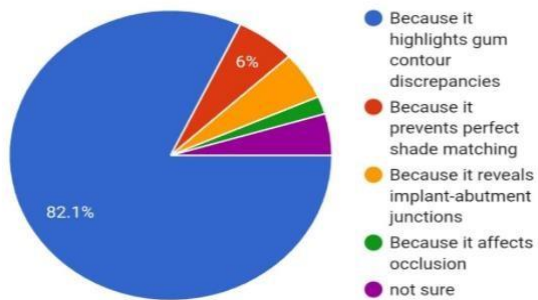
Around 80.1% identified excessive gingival display ("gummy smile") as a significant esthetic challenge for implant cases. This suggests students appreciate the impact of vertical display on implant esthetics and the need for comprehensive diagnosis and multidisciplinary management strategies.

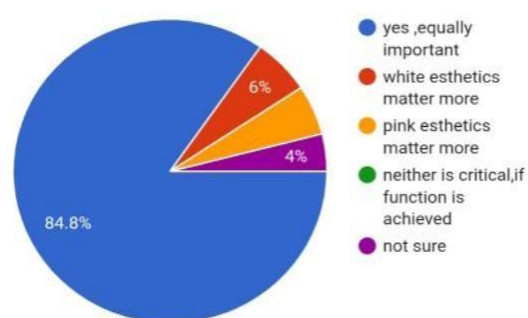## Q10. Soft-tissue grafting around implants
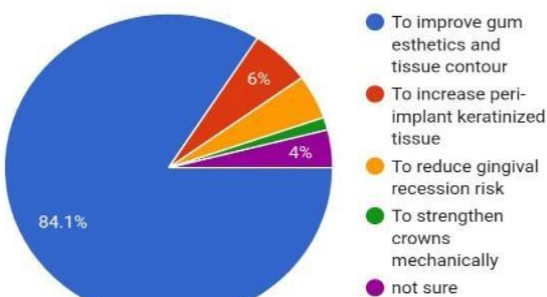
Most respondents (≈84.1%) recognized soft-tissue grafting as a means to improve peri -implant contour and reduce recession. This indicates sound understanding of surgical adjuncts that improve pink esthetics and long -term soft -tissue stability around implant restorations.

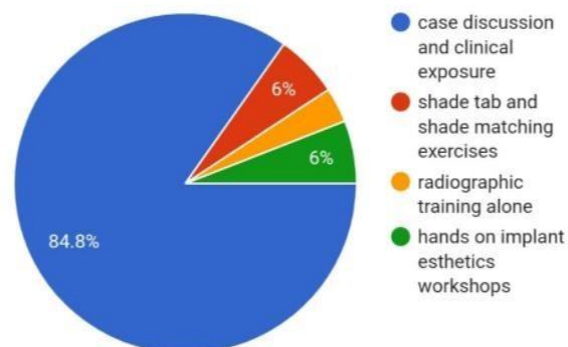## Q11. Which factor is most important for implant esthetics?
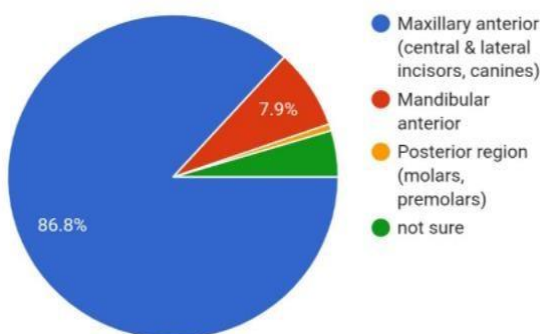
The plurality (≈63.6%) selected gingival and soft -tissue contour as the most critical esthetic factor, highlighting students' prioritization of peri -implant tissue architecture over isolated crown attributes. This reflects appropriate emphasis on the pink frame that supports an esthetic implant smile.

## Q12. Primary purpose of implant placement

Legend:
- Gingival asymmetry or black triangles
- Slight crown shade mismatch
- Crown length disproportion
- Occlusal interference
- not sure

(6.6%, 7.3%, 80.1%)

A majority (≈72.8%) agreed that implant placement primarily restores missing teeth and function, with esthetics as an essential but secondary objective. This demonstrates balanced understanding of implant goals: functional rehabilitation that must also sat   isfy esthetic demands, especially in the anterior zone.

## Q13. How should implant esthetics be taught?

Legend:
- yes ,equally important
- white esthetics matter more
- pink esthetics matter more
- neither is critical,if function is achieved
- not sure

(6%, 4%, 84.8%)

Most students (≈69.5%) preferred case   -based discussions and workshops, indicating a desire for interactive, clinically oriented learning rather than purely didactic lectures. This supports curriculum changes favoring hands -on esthetic training and realistic case simulations.

Q14. Most challenging tooth to match esthetically

Legend:
- case discussion and clinical exposure
- shade tab and shade matching exercises
- radiographic training alone
- hands on implant esthetics workshops

(6%, 6%, 84.8%)

Approximately 66.1% identified the maxillary central incisor as the most difficult tooth to match, reflecting awareness of its   critical role in symmetry, size, and prominence in the smile consistent with clinical experience that the central incisor demands exacting esthetic control

**Q15. Familiarity with "golden proportion"**
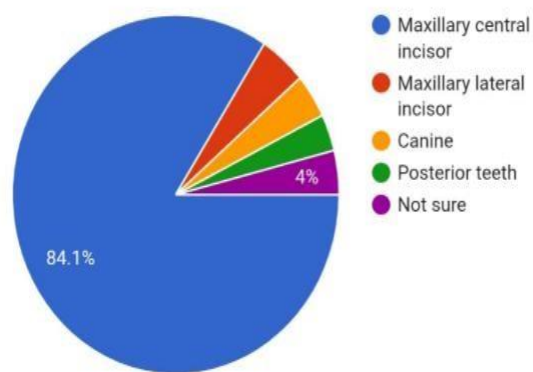
About 78.1% were familiar with the golden proportion concept in smile design, showing theoretical knowledge of esthetic proportions. While useful as a guideline, students should also learn individualized proportioning based on facial and dental context rather than rigid rules.

Q16. Part of crown most important for shade harmony
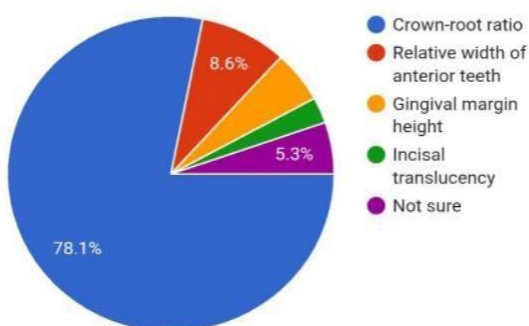
Over half (≈56.4%) chose the cervical third as most critical for shade harmony, reflecting understanding of natural color gradients and translucency toward the incisal edge. Emphasizing layered characterization during prosthesis fabrication would reinforce this concept practically.

**Q17. What makes a crown look unnatural even when shade is correct?**
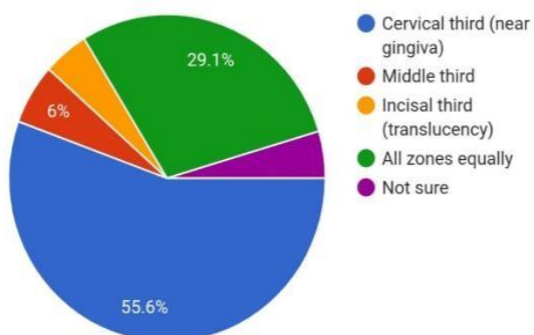
A majority (≈57%) identified incorrect proportions as the key cause, showing students appreciate that form and dimension are as important as color. This underscores the need to teach integration of morphology, texture, and proportion alongside shade selection.

**Q18. Preferred learning activity to improve white esthetics**
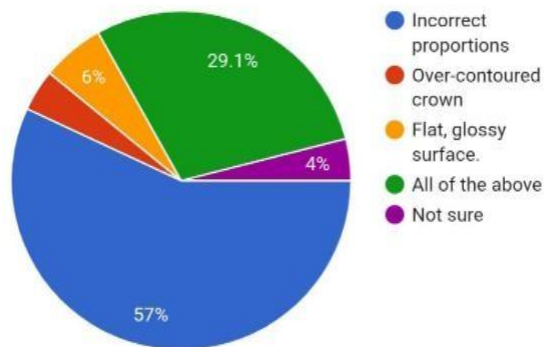
Most (≈59.6%) favored case discussions and clinical exposure to improve white -esthetic knowledge, indicating that experiential learning (clinical cases, prosthetic labs) is preferred for mastering crown morphology, shade handling, and surface characterization.

**Q19. Which surface feature makes crowns appear more life-like?**
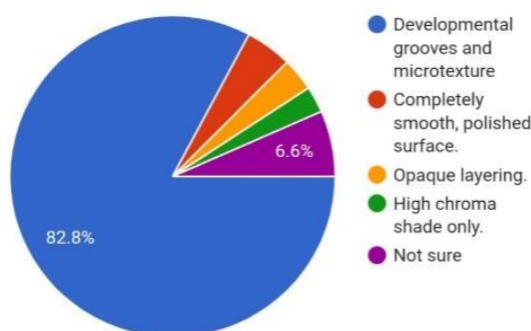
A strong majority (≈82.8%) chose developmental grooves and surface texture as key to lifelike crowns, reflecting good understanding that micro- and macro-texture create natural light scattering and visual depth beyond color alone.

**Q20. Most reliable method for shade selection in white esthetics**
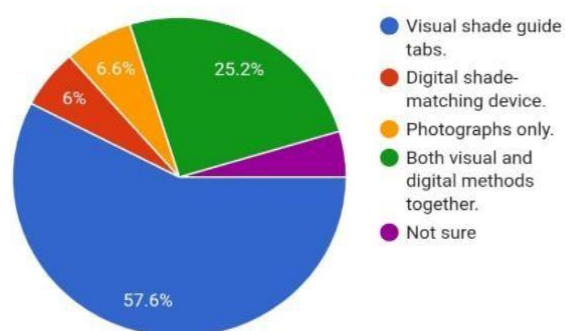
About 53.6% preferred visual shade guide matching, with others using photography or digital tools. While visual matching remains common, this split suggests an opportunity to increase training in calibrated photography and spectrophotometric methods for improved reproducibility.

**Q21. Most common reason for esthetic failure in implants**
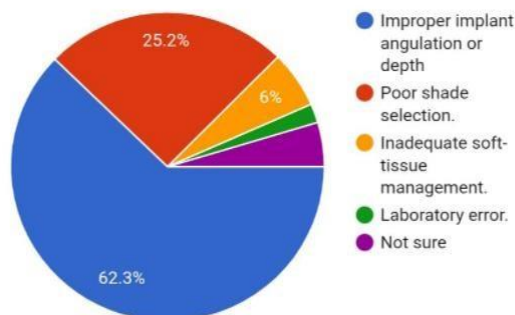
Around 65.2% attributed esthetic failure to improper implant angulation/positioning, showing awareness that surgical placement fundamentally influences prosthetic outcome and peri-implant tissue support; prosthetic compensation is limited if implant positi on is suboptimal.

Q22. Learning activity best improving knowledge of white esthetics
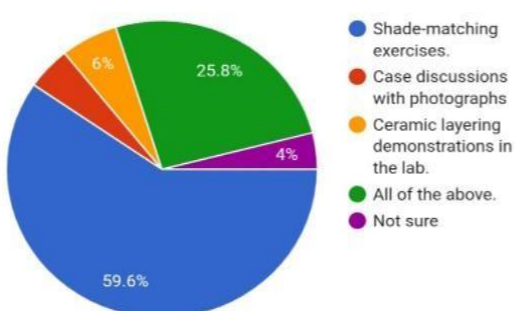
Most respondents (≈59.6%) again preferred case discussions and clinical exposure, reinforcing the students' recurring theme: applied, supervised practice and real case reviews are perceived as the most effective ways to learn white esthetic principles.

Q23. Belief that Digital Smile Design (DSD) improves outcomes
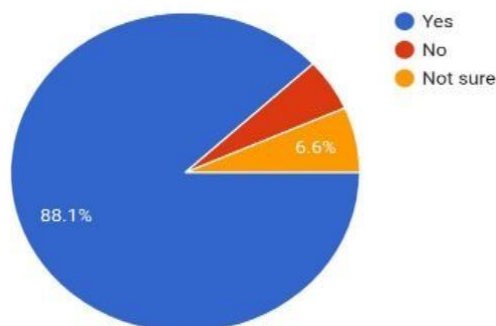
A large majority (≈88.1%) agreed that DSD enhances esthetic planning and communication, indicating strong confidence in digital workflows for visualization, treatment planning, and patient communication in implant smile cases.

Q24. Use of digital photography in esthetic planning
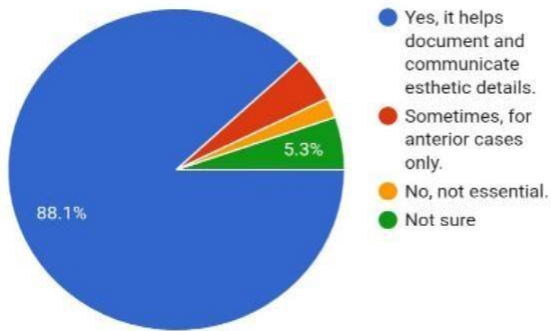
About 83.1% supported routine use of digital photography for documentation and shade assessment, showing recognition of photography's role in standardizing records, communicating with laboratories, and aiding objective esthetic decisions.

Q25. Influence of patient perception in treatment planning
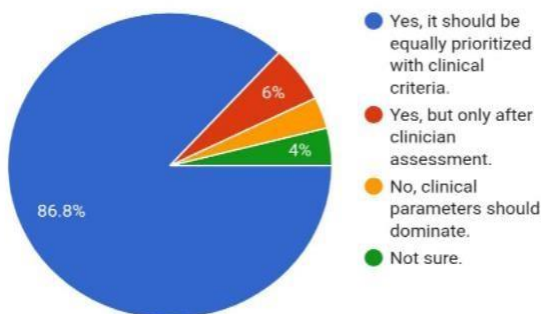
Nearly 85.4% believed patient perception should guide esthetic planning, reflecting a patient - centered approach where objective indices (PES/WES) are balanced with individual expectations and social/psychological factors that define satisfaction.

DISCUSSION

The present study provides critical insights into the perceptual competency of dental students regarding peri-implant esthetics, demonstrating a high level of theoretical awareness consistent with the growing emphasis on esthetic dentistry in modern curricula. More than 84% of participants reported familiarity with both pink and white esthetics, findings that closely align with those of Tettamanti et al. (2017) and Chugh et al. (2020), who documented similarly high levels of conceptual understanding among undergraduate dental cohorts. This supports the hypothesis that implant esthetics is increasingly recognized as an indispensable pillar of restorative success, reflecting a significant paradigm shift from the historical emphasis on osseointegration to a modern focus on biomimetic integration (Belser et al., 2009; Meijer et al., 2005).

Notably, 89.4% of respondents in this study demonstrated awareness of the Pink Esthetic Score (PES), and 82.8% recognized the White Esthetic Score (WES), reinforcing the findings of Fürhauser et al. (2005) and Belser et al. (2009), who established these indices as validated tools for objective esthetic assessment. This high recognition rate indicates successful dissemination of esthetic evaluation frameworks within the academic environment. These results are in agreement with Lin et al. (2018), who reported increasing adoption of PES/WES in academic training and clinical research. However, a minority of students remained uncertain about the clinical application of these indices, corroborating the findings of Coachman

and Calamita (2012), who emphasized a discrepancy between theoretical awareness and applied diagnostic ability among trainees.

The identification of gingival biotype (89.4%), mucosal contour (63.6%), and excessive gingival display (80.1%) as critical determinants of esthetic success supports the assertion by Hwang and Wang (2006) and Buser et al. (2011) that peri-implant soft-tissue morphology is a principal predictor of long-term esthetic stability. Similar observations were made by Goodacre et al. (2018), who highlighted patient satisfaction as directly proportional to soft-tissue integration rather than solely prosthetic design. In contrast, some authors, such as Meijer et al. (2005), have suggested that prosthetic parameters outweigh soft-tissue determinants in highly aesthetic cases, a view partially contradicted by the present findings, which demonstrate a stronger student emphasis on biological than prosthetic determinants.

Digital integration, particularly the recognition of Digital Smile Design (DSD) by 88.1% of participants, reflects a widespread acceptance of digital technologies as essential tools in esthetic planning. This trend is consistent with the reports by Joda et al. (2017) and Zarone et al. (2022), who described digital workflows as transformative in enhancing treatment predictability, clinician–patient communication, and prosthetic accuracy. Moreover, the positive perception of digital photography (83.1%) aligns with the findings of Chu et al. (2017), who demonstrated that digital imaging significantly improves color matching and optical integration in anterior implant cases.

Educational preferences in this study revealed a marked inclination toward experiential learning, with 69.5% of respondents favoring case-based and hands-on training over traditional lectures. This observation is supported by findings from Aggarwal et al. (2020), who reported that active learning strategies significantly improve clinical competence in esthetic implantology. Contrarily, studies in low-resource institutions (Rabiei et al., 2021) have reported student reliance on theoretical frameworks due to limited clinical exposure, suggesting that the degree of esthetic competency may be institution-dependent.

Furthermore, the present study revealed statistically significant associations between academic year and esthetic competency ($p < 0.05$), indicating that clinical exposure positively correlates with esthetic awareness. These findings align with those of Smith et al. (2019), who demonstrated that progression in dental education directly enhances diagnostic precision and decision-making in implant esthetics.

However, while the results largely support current literature, a few contrasting studies argue that esthetic awareness among dental students is often superficial and not retained long-term without clinical reinforcement (Perea-Peña et al., 2020). This observation underscores the need for structured simulation-based modules, digital planning integration, and objective esthetic assessment training throughout the undergraduate curriculum.

A primary limitation of this study is its reliance on self-reported perceptions rather than objective competency assessments, and the use of a single-institution sample, which may limit the generalizability of the findings to broader educational contexts. Future studies should incorporate multi-center cohorts and

longitudinal assessments with clinical skill evaluation to validate the effectiveness of esthetic education, while integrating digital simulation platforms and hands-on training modules may enhance clinical proficiency and esthetic decision-making in implant dentistry.

The convergence of clinical awareness, digital competency, and esthetic sensitivity among students suggests that dental education is effectively aligning with contemporary global standards. However, the noticeable absence of hands-on surgical experience among junior students highlights the need for early integration of simulation laboratories, digital planning workshops, and interdisciplinary esthetic modules.

CONCLUSION

This study demonstrated a high degree of theoretical awareness among dental students regarding peri-implant esthetic principles, reflecting strong academic integration of pink and white esthetics and the PES/WES evaluation system. The findings affirm a progressive shift toward digital and evidence-based implant dentistry, with students displaying strong acceptance of Digital Smile Design as a tool for enhancing treatment predictability. While clinical exposure remains limited, the positive perception of experiential and simulation-based learning highlights a crucial opportunity for curricular enhancement. These results emphasize the importance of advancing implant education beyond theoretical instruction to include handson esthetic training. Overall, the study provides a pivotal foundation for shaping esthetically focused competency in future dental professionals, aligning education with the demands of contemporary implant practice.

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