ORIGINAL ARTICLE

ASSESSMENT OF DENTAL STUDENTS' AND DENTISTS' KNOWLEDGE ON USING DIGITAL MODELS VS. PLASTER MODELS IN DENTISTRY

Diana-Elena Vlăduțu[1], Mihaela Roxana Brătoiu[1,*], Veronica Mercuț[1], Maria Roxana Pascu[1], Ioana Mitruț[1], Alexandra Maria Rădoi[1], Alexandru Ștefârță[2], Abdul Aziz Munajjed[3], Monica Mihaela Iacov-Crăițoiu[1], Monica Scrieciu[1]

[1] Department of Prosthodontics, Faculty of Dental Medicine, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania
[2] Department of Dental Technology, Faculty of Dental Medicine, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania
[3] Dentist with private practice, Craiova, Romania

All authors contributed equally to this work.

[*] Corresponding author: **Mihaela Roxana Brătoiu**, Department of Prosthodontics, Faculty of Dental Medicine, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania.
Email: mihaelabotila09@yahoo.com

Abstract: *Background*: In dentistry, study models are used for establishing comprehensive diagnosis, treatment planning, and evaluating post-treatment outcomes. Digitalization has become an indispensable component of the medical and dental fields, leading to the development of digital dental models. The present study aimed to investigate the knowledge of dental students and practitioners regarding the use of plaster models versus digital models for establishing dental diagnoses and treatment plans. *Methods*: The study was conducted on a representative sample of participants including students from the University of Medicine and Pharmacy of Craiova, Faculty of Dentistry and dental practitioners from Dolj County. The investigation of the students' and dentists' knowledge was carried out using a questionnaire-based method. The questionnaire included a set of 16 open-ended questions with single or multiple complementary responses, addressing several aspects. *Results*: Regarding the frequency of use of conventional plaster study models, 90% of respondents considered that they are still used in current clinical practice. Analysis of the responses regarding the comparison of the accuracy of digital models with that of plaster models indicated that 60% (n = 30) of participants stated that digital models have better accuracy. Regarding the use of study models in dental prosthesis design, 70% (n = 35) considered that designing is easier on digital models. *Conclusions*: The participants' opinions in the study highlighted that digital models provide greater accuracy of the information conveyed compared to gypsum models and also facilitate the design of prostheses more easily than gypsum models.

Keywords: digital model, plaster model, questionnaire

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1. Introduction

In dentistry, study models are used for establishing a comprehensive diagnosis, treatment planning, and evaluating post-treatment outcomes [1,2]. Thorough diagnosis and meticulous treatment planning enable the achievement of satisfactory and successful therapeutic results. Moreover, dental model analysis represents a valuable tool for examining occlusion and dentition in all three dimensions to assess the degree and severity of dental malposition and/or malocclusion for diagnostic and therapeutic purposes [3].

The gold standard for diagnostic measurements is the use of a caliper on gypsum models [4]. Conventional analyses of plaster models have been the most frequently employed form of model assessment from the past to the present due to the simplicity of the method [3].

Dental measurements performed on plaster models or photographs using a caliper are time-consuming [5] and prone to errors due to anatomical variations, individual factors, or factors related to tooth positioning and inclination [6]. Additionally, study models made of gypsum or dental cements are susceptible to damage and loss of accuracy caused by external factors [7].

In recent years, numerous advances in information technology have replaced traditional methods, offering modern and high-quality diagnostic tools at a reasonable cost [8]. Digitalization has become an indispensable component of the medical and dental fields, leading to the development of dental scanning techniques and the acquisition of digital dental models [9]. Digital models have become widely used in dental practices, with multiple options available for obtaining three-dimensional (3D) dental models [10].

The potential advantages of digital models arise from their ability to analyze dental and/or arch characteristics in a 3D manner, thereby eliminating the sources of measurement errors encountered in traditional methods [7]. Digital models offer numerous benefits, such as instant accessibility to 3D information without the need to retrieve plaster models from a storage area, reduced requirements for large storage spaces, faster analyses, the ability to share information online with other professionals, and objective (rather than subjective) evaluation of models according to the requirements for American Board of Orthodontics (ABO) certification [7,11]. The relationships between the maxillary and mandibular arches can also be visualized more clearly in occlusion, from multiple perspectives, in 3D images and software applications [12].

Digital models further allow for virtual treatment simulation and dental configuration planning [13]. 3D models can be processed to analyse individual teeth and estimate the axis or position of each tooth, providing a tridimensional prediction of tooth movement by superimposing dental changes on stable reference structures [7]. Additionally, digital models permit clinicians to use CAD/CAM applications (computer-aided design/ computer-aided manufacturing) for model analysis and for designing and fabricating appliances, particularly clear aligners [1].

Digital dental models can be obtained either by indirect scanning of impressions or plaster models using desktop laboratory scanners, or by directly scanning the dental

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arches with intraoral scanners [14,15]. Other methods for generating 3D digital models have also been proposed, such as those based on Con Beam Computer Tomograph data [16].

As a result of research and development in this field, Cadent (now Align Technology, San Jose, CA, USA) introduced in 1999 the first generation of OrthoCad™ software for "digital models" [3]. In 2006, the iTero Element intraoral scanner (Align Technology, San Jose, CA, USA) was launched, using parallel confocal imaging and point-by-point reconstruction to generate 3D computerized images [17].

This technology was later utilized for generating digital study models through various methods such as scanning alginate impressions or direct intraoral scanning, which may be more cost-effective and efficient, saving time and casting material compared with scanners used for plaster models [8].

Nevertheless, all these advantages can be considered valid only insofar as their accuracy and reliability are clinically demonstrated [3].

The scientific literature presents contradictory findings regarding the accuracy of dental measurements performed on digital models obtained by scanning plaster casts and offers limited data concerning digital models generated through impression scanning [3]. Previous reviews have confirmed that digital impressions obtained directly by intraoral scanning may be considered a viable alternative to alginate impressions in patients with a fully natural dentition [18,19].

In a recent systematic review, Alassiry stated that digital impressions may not be as precise as conventional ones, although intraoral scanners are considered clinically acceptable for orthodontic treatment planning, appliance fabrication, and clear aligner production [20].

These reviews recommended further research to compare digital impressions produced with different scanners, using diverse scanning strategies, as well as comparisons with other conventional impression materials [18,20].

Numerous studies have confirmed the validity [21,22], reliability [3,23], and reproducibility [24] of measurements performed on digital models compared with those on plaster models in permanent dentition. Although statistically significant differences between methods have been reported, these measurement discrepancies have not been considered clinically relevant [25,26]. Studies have also verified that digital measurements are clinically acceptable and not inferior for treatment planning [27].

However, while the digital method represents a clinically acceptable alternative to the analogue standard for analyzing permanent dentition, no comparative studies have been available for digital versus analogue measurements in children with mixed dentition. These situations differ because, instead of measuring all teeth, it is necessary to analyze a limited number of permanent teeth together with the supporting area. Thus, longer distances must be measured when examining the supporting area, which may be more difficult to assess accurately.

The present study aimed to investigate the knowledge of dental students and practitioners regarding the use of plaster models versus digital models for establishing dental diagnoses and treatment plans.

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2. Materials and method

The study was conducted on a representative sample of participants including students from the University of Medicine and Pharmacy of Craiova, Faculty of Dentistry and dental practitioners from Dolj County. The present study was observational, non-interventional, and cross-sectional in design. The implementation and conduct of the study were approved by the Ethics and University Deontology Committee of the University of Medicine and Pharmacy of Craiova, under approval No. 305/10.07.2025.

The investigation of the students' and dentists' knowledge was carried out using a questionnaire-based method. The questionnaire included a set of 16 open-ended questions with single or multiple complementary responses, addressing several aspects: the first four questions assessed the participant category, the following question explored the respondents' sources of information, the next three questions examined the participants' knowledge regarding the use of study models, and the remaining nine questions investigated knowledge related to plaster dental models and digital dental models. The questionnaire was uploaded to the Google Forms application and distributed online between 7–11 July 2025 via social media platforms in the form of a link, under the title "Questionnaire on Plaster Dental Models versus Digital Dental Models". The questions included in the questionnaire were:

1 *Specify the professional category you belong to*: Dental practitioner; Dental student
2 *If you are a practitioner, indicate how many years of professional experience you have*: 0–5 years; 5–10 years; over 10 years
3 *Indicate your gender*: Male; Female
4 *Select the information sources you use frequently*: Specialty textbooks; Artificial intelligence; Congresses, Conferences, Workshops; E-books, Online Webinars; Others
5 *Do you consider that study models are important for establishing the diagnosis and treatment plan?* Very important; Less important; Not important
6 *Which of the following elements do you consider can be analyzed on study models?* Shape and dimensions of edentulous ridges; Topography of remaining teeth; Coronal lesions of remaining teeth; Apical lesions of remaining teeth
7 *Which elements identified on study models do you consider are taken into account in treatment planning?* Direction of inclination of remaining teeth; Position of remaining teeth; Dimension of missing teeth; Dimension of the edentulous ridge
8 *Based on your experience, do you consider that plaster models are still used nowadays?* Yes; No
9 *Which factors do you believe influence the accuracy of a plaster model?* Application of a correct impression technique; Type of impression material; Time interval between impression making and model pouring; Type of gypsum used for casting the model
10 *Do you consider that storage of plaster models is influenced by environmental temperature?* Yes; No

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11 *Based on your experience, how frequently are digital study models used?* Very frequently; Rarely; Very rarely

12 *Digital models can be obtained through:* Intraoral scanning; Scanning of plaster models; Scanning of dental impressions; Processing of CBCT data

13 *Have you participated in obtaining a digital model through intraoral scanning?* Frequently; Rarely; Never

14 *What do you consider to be the advantages of obtaining digital models through intraoral scanning?* Reduced time; Lower costs; Patient comfort; Additional digital training required for the practitioner

15 *Do you consider that the accuracy of digital models, compared with plaster models, is:* Approximately similar; Better; Worse

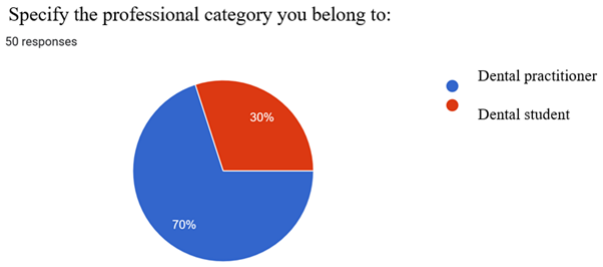
16 *Do you consider that designing a dental prosthesis is easier on:* Digital models; Plaster models

The results of the questionnaire-based study were processed using descriptive statistical analysis, and the data obtained from the case study were expressed numerically.

3. Results

The responses obtained from the questionnaire completed by the participating dental students and practitioners were analyzed. Analysis of the results obtained in the present questionnaire-based study

Following the centralization of the responses to the questionnaire distributed online, it was observed that responses were received from 50 participants, of whom 30% (n = 15) were students and 70% (n = 35) were dental practitioners (Figure 1).



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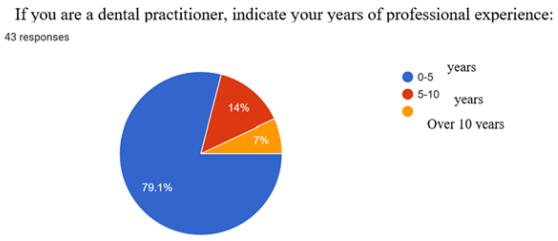

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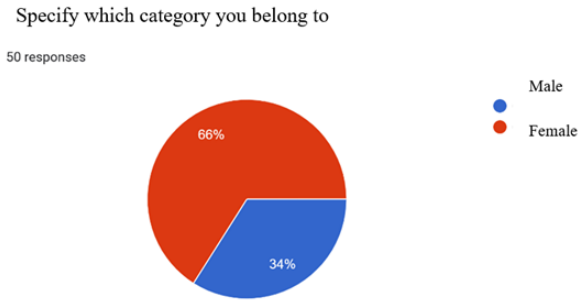

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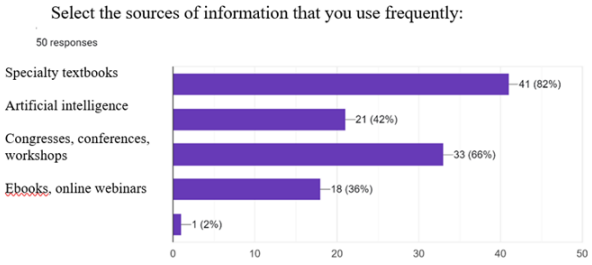

(Figure 4)

Figure 1. Distribution of study participants according to professional cate. **Figure 2.** Distribution of dental practitioner participants according to years of clinical experience. **Figure 3.** Distribution of participants by gender. **Figure 4.** Distribution of participants according to the information sources used.

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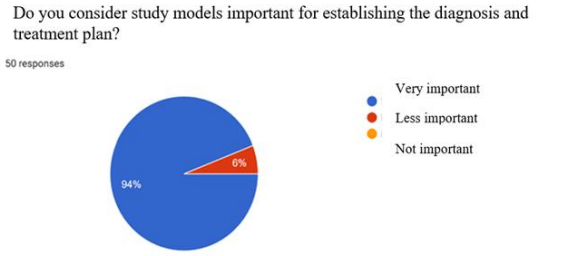
The next question investigated the number of years of professional experience among the participating dental practitioners. The results showed that 26 respondents had between 0–5 years of experience, 6 respondents had between 5–10 years of experience, and 3 respondents had more than 10 years of clinical experience (Figure 2). The third question explored the level of study of the participating dental students. Analysis of the responses showed that all 15 students were in their 6th year of study. Regarding the gender of the participants, the analysis indicated that 66% (n = 33) were male and 34% (n = 17) were female (Figure 3). Analyzing the participants' responses regarding the information sources they use, it was found that 82% (n = 41) reported that they most frequently use specialty textbooks, 66% (n = 33) indicated that their primary source of information is participation in congresses, conferences, and workshops, and the third most cited source was the use of artificial intelligence (42%, n=21) (Figure 4).



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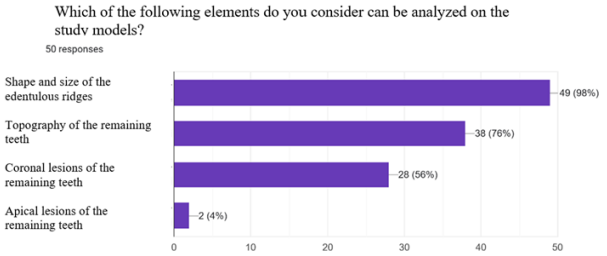

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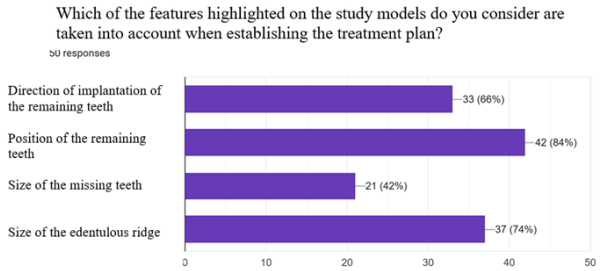

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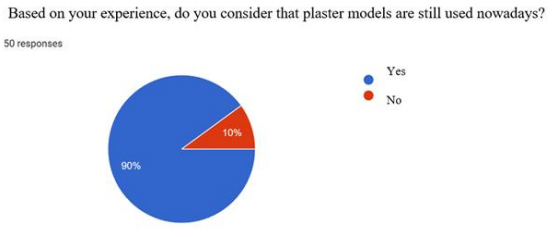

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Figure 5. Distribution of participants according to their opinion on the importance of study models. **Figure 6.** Distribution of responses regarding the elements analyzed on study models. **Figure 7.** Distribution of responses regarding the factors that influence the treatment plan. **Figure 8.** Distribution of respondents according to their opinion on the frequency of plaster model use.

In response to the question regarding the importance of study models for establishing the diagnosis and treatment plan, 94% (n = 47) indicated that they represent very important tools in clinical practice, while 6% (n = 3) considered that study models are of lesser importance. None of the participants stated that study models are not important (Figure 5). Regarding the elements that can be analyzed on study models, 98% (n = 49) of participants mentioned the shape and dimensions of the edentulous ridges, 76% (n = 38) indicated the topography of the remaining teeth, and 28% reported that coronal lesions of the remaining

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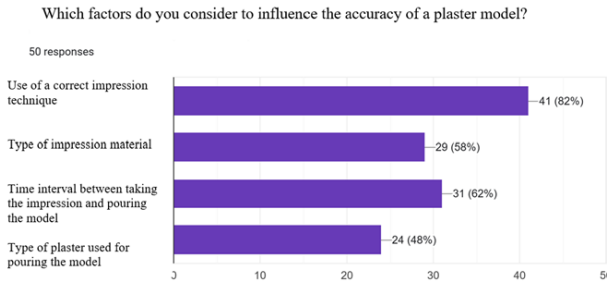
teeth can be analysed on study models (Figure 6). The investigation of knowledge regarding the elements highlighted on study models that influence the treatment plan yielded the following responses: 84% (n = 42) of participants mentioned the position of the remaining teeth, 74% (n = 37) indicated the dimension of the edentulous ridge, and 66% (n = 33) considered that the direction of inclination of the remaining teeth influences the treatment plan (Figure 7). Regarding the frequency of use of conventional plaster study models, 90% of respondents considered that they are still used in current clinical practice (Figure 8).



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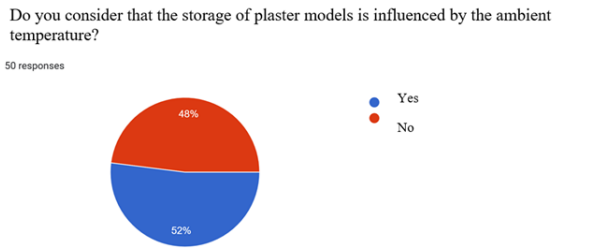

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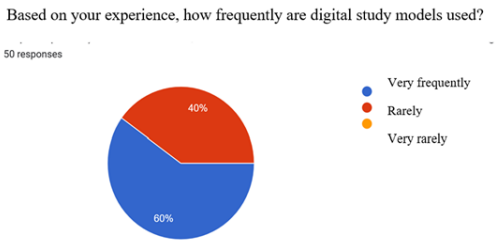

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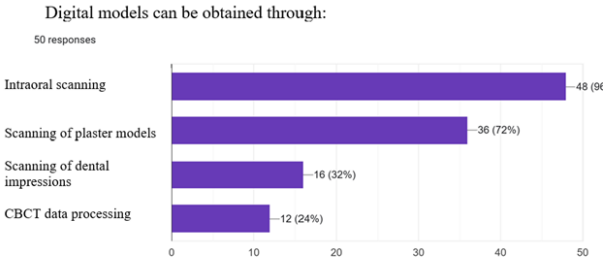

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Figure 9. Distribution of responses regarding the factors influencing the accuracy of a plaster model. **Figure 10.** Distribution of participants according to their opinion on the storage of plaster models. **Figure 11.** Distribution of respondents according to their opinion on the frequency of digital study model use. **Figure 12.** Distribution of responses regarding the methods of obtaining digital study models.

The question regarding the factors that may influence the accuracy of a plaster model was a multiple-response item. The recorded responses highlighted that the use of a correct impression technique is the main factor affecting the accuracy of a plaster model (82%, n = 41), while the time interval between taking the impression and pouring the model was also considered an important factor (62%, n = 31) (Figure 9). In relatively equal proportions, 52% and 48% of the study participants considered that environmental temperature does, respectively does not, influence the storage of plaster models (Figure 10). The next question explored the participants' opinions regarding the frequency of use of digital study models. The analysis of the responses revealed that 60% and 40% of them reported very frequent and rare use of digital study models, respectively (Figure 11).

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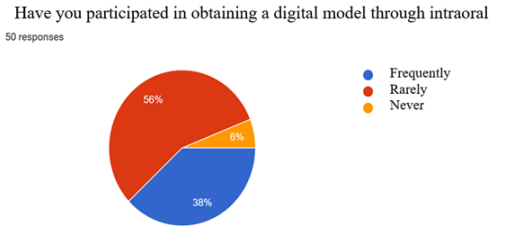
Analyzing the methods for obtaining digital models, the study results highlighted that 96% (n = 48) of participants mentioned intraoral scanning as a means of obtaining a 3D model. Another frequently used method for obtaining digital study models was considered to be scanning of plaster models, with 72% (n = 36) of participants indicating this method (Figure 12). Among the 50 study participants, 56% (n = 29) reported that they had rarely participated in obtaining a digital model through intraoral scanning, 38% (n = 19) stated that they had participated frequently in such a procedure, and 6% (n = 3) mentioned that they had never participated (Figure 13).

The main advantage of obtaining digital models through intraoral scanning was considered to be the reduction of working time, mentioned by 92% (n = 46) of participants. Other advantages reported by participants included patient comfort (74%, n = 37) and lower costs (38%, n = 19) (Figure 14). Analysis of the responses regarding the comparison of the accuracy of digital models with that of plaster models indicated that 60% (n = 30) of participants stated that digital models have better accuracy, 36% (n = 18) reported that the accuracy of the two types of models is similar, and 4% (n = 2) considered that the accuracy of digital models is inferior to that of plaster models (Figure 15). Regarding the use of study models in dental prosthesis design, 70% (n = 35) considered that designing is easier on digital models, while 30% (n = 15) indicated that designing a dental prosthesis is easier on plaster models (Figure 16).



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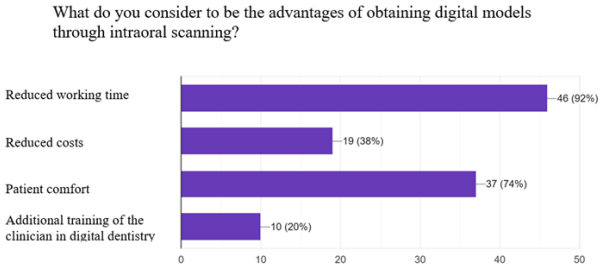

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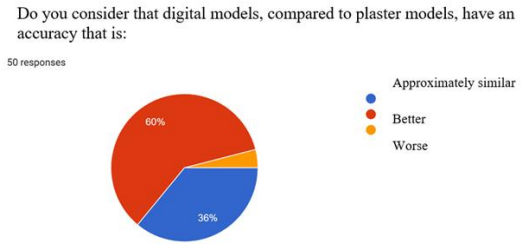

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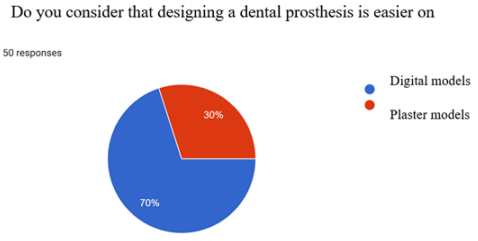

(Figure 16)

Figure 13. Distribution of participants according to their participation in obtaining a digital model through intraoral scanning. **Figure 14.** Distribution of responses regarding the perceived advantages of intraoral scanning. **Figure 15.** Distribution of responses regarding the accuracy of digital and plaster study models. **Figure 16.** Distribution of responses regarding the methods of obtaining digital study models.

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4. Discussion

The present study investigated the knowledge of dental students and dentists regarding the use of gypsum study models compared with digital models. Among the 50 respondents, 70% were dentists, indicating a greater interest among practitioners in the type of study models used in prosthodontics. The results are consistent with the findings of Hall et al., who reported that 28.6% of participants were postgraduate students, while the remaining respondents were practicing clinicians from various specialties [28].

The results of the current study also showed that interest in this topic was higher among female participants (66%), similar findings being reported by Schott et al., who noted that more than 70% of participants in a comparable study were also female [29].

This aspect is further supported by the fact that 94% of participants stated that the study model is highly useful for establishing the diagnosis and designing the therapeutic steps. Moreover, these results indicate that, regardless of the technology used to obtain it, the study model is perceived as an indispensable tool in dentistry.

Physical dental casts remain integral across all branches of dentistry, including orthodontics, prosthodontics, implantology, and oral and maxillofacial surgery, as they constitute essential diagnostic tools. They play a pivotal role in treatment planning, communication with patients and dental technicians, the fabrication of various appliances, preoperative simulation and training, as well as educational activities [30,31,32]. The use of these digital model–acquisition methods may facilitate the replacement of physical dental casts, thereby enhance cost-effectiveness and minimizing the need for storage space [33-35].

The study demonstrated that the use of study models in routine clinical practice holds significant importance, as these models enable the assessment of prosthetically relevant features that support prosthesis design. The participants identified the following elements as prosthetically significant: the position of the remaining teeth (84% of respondents), the dimensions of the edentulous ridge (74% of respondents), and the angulations of the remaining teeth (66% of respondents).

In the present study, 90% of respondents reported that gypsum study models are still used in clinical practice, while at the same time, 60% indicated very frequent use of digital models. These findings align with the results of Husain et al., who showed that practicing dentists preferred both digital and conventional study models, whereas dental graduates favored digital models to a greater extent than conventional ones [36].

The analysis of the responses regarding the accuracy of gypsum models reveals a high level of theoretical awareness among the participants. Both dentists and students correctly and frequently identified the main factors that may compromise the final accuracy of the model. Options such as “Applying a correct impression technique,” “Type of impression material,” “Time interval between impression taking and model pouring,” and “Type of gypsum used for model fabrication” were commonly selected, demonstrating a solid understanding of the analog procedural chain. Moreover, the nearly equal distribution of opinions concerning the

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influence of ambient temperature on the preservation of gypsum models indicates recognition of the material's dimensional instability—an intrinsic vulnerability. However, findings from the study conducted by Ovsenik et al. showed that a gypsum model can still be stored, handled, and analyzed effectively when proper lighting and suitable measuring instruments are used [37].

Regarding the possibilities for obtaining digital study models, in the present study most respondents indicated intraoral scanning (92%) and scanning of gypsum models (72%). Only 32% mentioned impression scanning, and 24% noted that CBCT data can also be processed to generate digital models. Similar results were reported by Husain et al., who found that 80% of participants identified intraoral scanning as the primary method for acquiring 3D models [36].

Other studies have highlighted that dentists' opinions concerning the use of digital technologies, as well as the factors that motivate their professional activities, vary according to the level of technology implemented [38].

In the present study, several advantages of digital models were identified in descending order of frequency, namely: reduced working time, improved patient comfort, and lower costs.

Similarly, in the study conducted by Schott et al. [29], nearly 100% of participants reported reduced working time and increased patient tolerance with respect to handling the intraoral scanner as the main advantages.

Regarding the accuracy of the information provided by the two types of models—digital and plaster, the respondents indicated that digital models offer more reliable and accurate information compared with plaster models. Similarly, the findings of the study conducted by Abizadeh N., 2012 highlight that digital models represent a valid and efficient alternative for clinical diagnosis; however, plaster models may still be preferred in certain scientific research contexts where a higher level of precision and fewer discrepancies in occlusal analysis are required.[39].

Regarding the ease of designing dental prostheses using digital models versus plaster models, 70% of the study participants preferred the use of digital models. The results are consistent with those reported by Ahmed et al., 2018, who stated that digital technology can make the planning and execution of restorations more efficient and faster ("streamlined and efficient"), although they noted that the outcomes are not always more accurate than those obtained with conventional methods. The authors also mentioned that in surveys involving dentists, many acknowledge the significant role of CAD/CAM, but its adoption in routine clinical practice is limited by barriers such as cost [40].

The limitations of this study arise from the small number of respondents included in the two participant categories. Moreover, the respondents were students or graduates of the same university center; therefore, their knowledge regarding the acquisition and use of digital and plaster models was limited to the information provided during their training at that institution.

The questionnaire did not assess detailed knowledge about the procedures involved in obtaining and using the two types of study models.

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5. Conclusions

1. Study models are routinely used in dental practice for establishing diagnoses, treatment planning, and post-therapeutic evaluation, allowing the analysis of multiple factors.

2. The results of the questionnaire-based study highlighted greater interest in the topic among dental practitioners with fewer years of experience compared to students. Analysis of the responses indicated concurrent use of both plaster and digital study models, awareness of the advantages and disadvantages of each type, as well as understanding of their potential applications in dental prosthesis design.

3. The study showed that the participants demonstrated knowledge of obtaining digital models through intraoral scanning and scanning of study models.

4. The participants' opinions in the study highlighted that digital models provide greater accuracy of the information conveyed compared to gypsum models and also facilitate the design of prostheses more easily than gypsum models.

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Conflict of interest statement

The authors declare no conflicts of interest concerning this study.

Data availability statement

Will be provided on request.

Ethics statement

This study was approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova (approval data no. 305/10.07.2025).

ORCID

Diana Elena Vlăduțu: https://orcid.org/0009-0007-6639-7847
Mihaela Roxana Brătoiu: https://orcid.org/0009-0002-9220-3616
Ioana Mitruț: https://orcid.org/0000-0002-4843-1278
Monica Scrieciu: https://orcid.org/0000-0003-0696-7100

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