

Awareness and Knowledge of Digital Dentistry amongst Undergraduate Dental Students at an Academic Institution in the UAE: A Cross Sectional Study

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Abstract

Dental profession is rapidly evolving due to advanced digital technology. Several automated technologies such as laser, intraoral scanners, cone beam computed tomography (CBCT), Computer Aided- Design/Computer Aided Manufacturing (CAD/CAM) technology, and 3D printing offer new possible alternatives to replace manual tasks and increase the quality of treatment and patient experiences.

To assess the awareness and knowledge about digital dentistry among undergraduate dental students at Gulf Medical University, Ajman. A questionnaire comprising 16 questions about digital dentistry and sociodemographic data was distributed amongst 1st, 2nd, 3rd, 4th, and 5th year undergraduate dental students. A total of 252 students voluntarily participated in the study. The information obtained was statistically analysed. It was observed that dental students in the 3rd, 4th, and 5th years were more informed about digital dentistry when compared to the 1st and 2nd year students.

The awareness among undergraduate dental students about digital dentistry is satisfactory on a broad aspect. However, there is a lack of knowledge in relation to deeper aspects of digital dentistry which demonstrates a need for further awareness. This can be attained by implementing educational courses on digital dentistry in the preclinical years of the dental curriculum. Such an action would provide students with the required knowledge of the various technologies used in the clinical setting.

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Introduction

The production and deployment of the internet and technologies have evolved in recent decades. However, the digital era has not spared the dental field. The digital transformation process has resulted in the development of data that is generated by computers in many dental sectors, such as prosthodontics, orthodontics, and oral and maxillofacial surgery.^{1,2} Increasing advancement of the digital workflow has changed

the daily practice in every area of dentistry. It enables surgeons to plan implants and their restorations more efficiently and accurately in an immersive three-dimensional setting, create surgical instructions, and, if needed, instantly start recovery in one session. As a result, dental research is currently focused on examining the several possible important attributes of digital generated data in the dental field and research.³⁻⁸

The use of Cone Beam Computed Tomography (CBCT), Computer Aided-Design/Computer Aided Manufacturing (CAD/CAM), three dimensional (3D) printers, and tele-dentistry are all included under the term digital dentistry. Although each aspect is fascinating on its own, the role of each of these systems is essential to today's dentistry. The greatest advantages of this process range from 3D printing of an entire complete denture on the same day and producing a single crown in the dental office in just a few hours. Although all

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these technologies can be used to support development, they also provide opportunities for learning and knowledge sharing.⁹

One of the most significant advantages of digital dentistry today is the ability to store all relevant information in a computerized form. Information exchange and storage are virtually uncomplicated because these devices are no longer dependent on basic physical files. Digital files and templates can be displayed in the same amount of time as keys are pressed on a keyboard which can be operated in a variety of ways.¹⁰

The comprehension of digital dentistry is essential to dental practitioners in today's constantly evolving world. Dental professionals recognize the necessity to adopt digital dentistry as a way to influence the future of dental treatment as the field continues to change towards advancements in technology. Although digital dentistry clearly outperforms traditional methods there are still a lot of factors to consider at each stage. Affordability of machines and technology due to the costs at the start and staff preparation are two major current step backs. Furthermore, the specificity, accuracy, and consistency of all three dimensions, both individually and in combination, can be unclear.¹⁰ Keeping this in mind, our study was conducted to evaluate the awareness and knowledge of undergraduate dental students about digital dentistry.

Materials & methods

The research study was an experimental cross-sectional study which was approved by the institutional review board (IRB) committee. The questionnaire focused on retrieving information about the most used technologies in dentistry. It consisted of 16 carefully drafted questions about sociodemographic data such as the participants age, and gender, and the awareness and knowledge about CBCT, CAD/CAM, tele-dentistry, and 3D printing. The questionnaire was distributed equally amongst 1st, 2nd, 3rd, 4th, and 5th year undergraduate dental students.

A total of two hundred and fifty-two responses were received from dental students who consented to participate. The data was collected over a period of 6 months. The completed responses were entered on an Excel spreadsheet and further imported into IBM

Statistical Package for Social Sciences (SPSS) software version 28 for statistical data analysis.

The data analysis was carried out by a statistician. Statistical analysis was performed by SPSS in general, while Microsoft Office Excel was used for data handling and graphical presentation. The result was presented as percentages in the form of graphs.

Results

Sociodemographic Data

The findings of our study reported that among all the respondents (252), 163 (65%) were females and 89 (35%) were males. Students of various ages on campus were surveyed and it was discovered that the majority of the respondents 163 (68%) were students less than or equal to the age of 21 years, while 78 (32%) students were above the age of 21 years. Participants of our research were limited to the Bachelor of Dental Surgery (BDS) program with the survey consisting of an equal response rate from the students of 1st, 2nd, 3rd, 4th, 5th years.

Majority of the participants 192 (77%) were aware of the terminology digital dentistry, although 58 (23%) of the participants were not. Our study gives an insight of the various modes via which the participants may have heard or learned about digital dentistry. Majority of the participants, 71 (30.6%) knew about digital dentistry through the internet (social media), followed by 56 (24.1%) who learned by faculty, 55 (23.7%) were aware through seminars and workshops, whereas 50 (21.6%) of the participants learned about digital dentistry through other resources such as marketing events at conferences, advertisements at dental clinics, newspaper articles, and word of mouth.

Awareness and Knowledge about CBCT

Majority of the participants 175 (70%) were aware of the technology CBCT in-relation to dental radiography, while 75 (30%) of the participants were not aware (Fig 1a). Furthermore, on assessing the knowledge of the participants about the advantages of CBCT over other diagnostic imaging methods, 111 (44.9%) of the participants chose better imaging processing as the major advantage of CBCT over other diagnostic imaging methods, whereas 10.5% thought faster scanning could be an advantage CBCT over other diagnostic imaging

methods. 38 (15.4%) participants chose a lower radiation dose as an advantage and 72 (29.1%) of the participants did not know the advantages of CBCT (Fig 1b).

Awareness and Knowledge about CAD/CAM

On assessing the awareness about CAD/CAM, 167 (66.8%) participants had heard of CAD/CAM and only 83 (33.2%) participants were not aware (Fig 2a). The study further evaluated the knowledge of participants regarding the different types of materials used in CAD/CAM technology, out of 252 participants, 37 (14.9%) of the participants chose metal, 90 (36.3%) chose zirconium wax, and majority of the participants, 121(48.8%) didn't know which material can be used with CAD/CAM technology (Fig 2b). Participants when asked if a complete denture could be manufactured by CAD/CAM technology, 167 (67.9%) of the participants thought that a complete denture could be manufactured using CAD/CAM, whereas 79 (32.1%) of the participants thought it could not be manufactured (Fig 2c).

Awareness and Knowledge about Tele-dentistry

The study went on to evaluate if participants were aware about of tele-dentistry, out of the 252 participants, 101 of the participants were aware of tele dentistry and 145 of the participants were not aware (Fig 3a). The study also evaluated the participants knowledge about how is the tele-dentistry technology used, out of 252 participants, majority of the participants 132(53.2%) didn't know how to use tele-dentistry, However 80 (32.3%) of the participants said that it can be used via telephone or an online meeting, 15(6%) of the participants answered that tele-dentistry can be used with media, whereas 21 (8.5 %) people chose that tele-dentistry can be used in the clinic (Fig 3b). The study then proceeded to assess the participants, if the technology of tele-dentistry can be used for good oral hygiene training. Out of 252 respondents, 174 (71.6%) answered yes, tele-dentistry is used for good oral hygiene training, however 69 (28.4%) answered no (Fig 3c).

Awareness and Knowledge about 3D printing

The study assessed if the participants were aware of the use of 3D printing in digital dentistry, out of 252, majority of the respondents 206 (83%) were aware of the use of 3D printing in digital dentistry. (Fig 4a). The study further evaluated the possible applications of 3D printing in the dental practice out of 252, majority of the participants 157 (63.1%) chose all of the above option. However, 41 (16.5%) of the participants didn't know the possible applications of 3D printing in dentistry, while 19 (7.6%) of the people chose diagnostic casts and models can be prepared with the use of 3D printing. Furthermore, 12 (4.8%) of the participants chose that digital orthodontics (aligners and mouthguards) is a possible application of 3D printing, 11(4.4%) of the respondents chose that partial dentures are a possible application of 3D printing, 8 (3.2%) of the respondents chose that fabrication of crowns and bridges is possible. On the other hand, only 1 (0.4%) participants chose that none of the above applications are possible with 3D printing (Fig 4b).

Lastly, the study evaluated if the participants think that digital dentistry can improve the quality of treatment, out of 252 respondents, majority 224 (90%) answered yes, digital dentistry can improve the quality of treatment, while only 25 (10%) answered no, digital dentistry cannot improve the quality of treatment (Fig 4c).

Discussion

Dental profession is rapidly evolving due to advanced digital technology. The use of emerging technology in dentistry, combined with reliable procedures and precisely high strength materials is displacing obsolete methods. Several automated technologies such as lasers, intraoral scanners, CBCT, CAD/CAM technology, and 3D printing offer new possible alternatives to replace manual tasks and increase the quality of treatment and patient experiences¹¹. Research shows that digital dentistry is significantly transforming patient treatment and restorative solutions, particularly in recent years, through improved digital workflow in various dental fields. CBCT enhances diagnostic datasets, while 3D fabrication methods and CAD/CAM techniques enable novel treatment models in implant

dentistry¹². The digital revolution offers new opportunities and challenges, necessitating knowledge about new devices, applications, and machines, and effective integration into workflows¹³.

With this background, our team decided to assess the awareness and knowledge about digital dentistry among undergraduate dental students of Gulf Medical University, Ajman. In the present study, it was observed that the ratio of females to males was 6:4 (65% females and 35% males), and that the majority of the participants (68%) were less than or equal to 21 years. In a study carried out by Scarbecz *et al*¹⁴ concerning the purpose for seeking a career in dentistry, female dental students placed a higher value on people-oriented purposes such as caring for patients as well as a well-balanced work life, whereas male dental students prioritised independent employment and business-related interests.

Our research was limited to the students of the Bachelor of Dental Surgery (BDS) program. Majority of the participants (77%) were aware of the terminology digital dentistry, while 23% were not aware. Regarding the mode of awareness, multiple choices were given; 30.6% of the respondents knew about digital dentistry through the internet (social media), 24.1% through lectures given by the faculty, and 23.7% through seminars and workshops. In a study conducted by Temur *et al*¹⁵, the results differed, as obtaining knowledge through the internet was the least common choice 6.7%, which on the contrary was the most preferred option in the present study.

In our study 70% of the participants were aware of the technology CBCT, whereas only 30% were not aware. Our results were concurrent with the study conducted by Bhagat *et al*¹⁶ who reported that out of 150 participants, 48.6% were aware of CBCT. Furthermore, 44.9% of the participants agreed that CBCT had better imaging processing when compared to traditional diagnostic methods which is in agreement to a study done by Saptadi *et al*¹⁷ who stated that when dentists used CBCT scan along with other diagnostic imaging methods, it improved image processing and improved location of impacted third molars in relation to the mandibular canal. Furthermore, 29.1% didn't know the advantages, 15.4% saying lower radiation dose and only 10.5% chose faster

scanning. In another study performed by Bhagat *et al*¹⁶ majority of their participants chose reduced radiation as the main advantage of CBCT. The results were different because their study used working dentists as their participants, and we used students as our participants.

CAD/CAM is a rising digital technology and is known for being user and patient-friendly and accurate. Since it is an emerging digital technology, we asked our participants if they had heard of CAD/CAM, 66.8% had heard of the digital technology CAD/CAM whereas 33.2% did not. Our results were similar to a study done by Maltar *et al*¹⁸ who reported that the majority of their participants (84.23%) had heard of CAD/CAM. On further assessing the knowledge of dental students about CAD/CAM, it was observed that the majority (48.8%) of the participants did not know which materials can be used with CAD/ CAM technology, 36.3% chose zirconium wax and 14.9% chose metal. Our results were concurrent with a study by Hegde *et al*¹⁹ where 70% of the students were not aware of the materials used in CAD/CAM technology and this was because only 35% of undergraduate students had seen a CAD/CAM technology unit and its materials and 67% of the students stated that their curriculum does not help them in knowing about CAD/CAM technology. In addition, we also observed that 67.9% of the participants agreed that CAD/CAM can be used for complete denture fabrication. Our results were concurrent to the studies reported by Hegde *et al*¹⁹ and Bhaskar *et al*²⁰ who observed that 78% and 70% of their respondents respectively, were aware that one of the applications of CAD/CAM was complete denture fabrication.

Tele dentistry is the use of information technology to facilitate remote dental care, advice, and education instead of direct face-to-face communication with patients. 58.9% of our participants were not aware of tele dentistry, together with 53.2% who did not know how to use tele dentistry. These results were similar to a study done by Aboalshamat²¹, who reported that only 17.9% of the dental students were aware of the term tele dentistry; this could be due to the fact that the participants had never used teledentistry before. Tele dentistry is a new concept, and therefore has low student awareness due to its low practice by dental health professionals. Furthermore, our study assessed if tele-dentistry can be used for good

oral hygiene training, 71.6% of our respondents agreed. A similar finding was observed in a study conducted by Boringi et al ²² who reported that 79.59% of the participants concurred that tele dentistry can be a decent tool for oral hygiene training.

On evaluating the awareness on the use of 3D printing technology, we observed that 81.7% of participants were aware and 17.3% were not. The global recognition and education on the growing use of 3D printing in dentistry is crucial. 63.1% of our participants chose all of the listed options (diagnostic casts and models, fabrication of crowns and bridges, digital orthodontics such as aligners and mouthguards, partial dentures) as applications of 3D printing in dentistry, 16.5% were not aware, and 7.6% of the participants thought that diagnostic casts and models are possible applications. In comparison to a study conducted by Dhokar et al ²³ reported that 29.2% of the participants accredited its use in printing diagnostic models and casts. This indicates that only a few of the participants were aware of this application. Furthermore, the study conducted by Dhokar et al ²³ indicated that 27.3% of the participants were aware of the 3D printing application of digital orthodontics which demonstrated a higher awareness than in our study (4.8%). In addition, 4.4% of our participants chose partial dentures fabrication, surprisingly only 1 participant 0.4% chose that none of the above applications provided could be an application of 3D printing in dentistry.

Lastly our study assessed the opinion of the participants on whether digital dentistry improves the quality of treatment, 88.9% agreed whereas 11.1% did not. Our results were concurrent with a study done by Saponaro et al ²⁴ who stated that 70% of seasoned complete denture wearers felt that they had a better experience with their digitally fabricated dentures than their previous traditionally fabricated dentures.

Overall the recent advancements in the field of dentistry across universities in the world

and the requirement for dental students to know about various digital dentistry based technologies necessitated the establishment of a state-of-the-art digital dentistry laboratory at the College of Dentistry along with the inclusion of digital dentistry training workshops for dental students. Furthermore, in comparison to the previous cohorts, advanced digital dentistry based courses such as "Artificial Intelligence" in year 4 (semester 8) and "Digital Dentistry and 3D Printing" in year 5 (semester 9) were introduced in the dental curriculum.

Conclusion

In conclusion, the present study results indicate that the awareness regarding digital dentistry and its applications should be studied more. Henceforth, the authors suggest the addition of digital dentistry courses in the preclinical years of the dental curriculum, and the inclusion of workshops and seminars to give students a more hands-on approach to different digital dentistry technologies. This would help students gain more knowledge of the various digital dentistry technologies that they will eventually use in the clinical setting.

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Declaration of Interest

The authors report no conflict of interest.

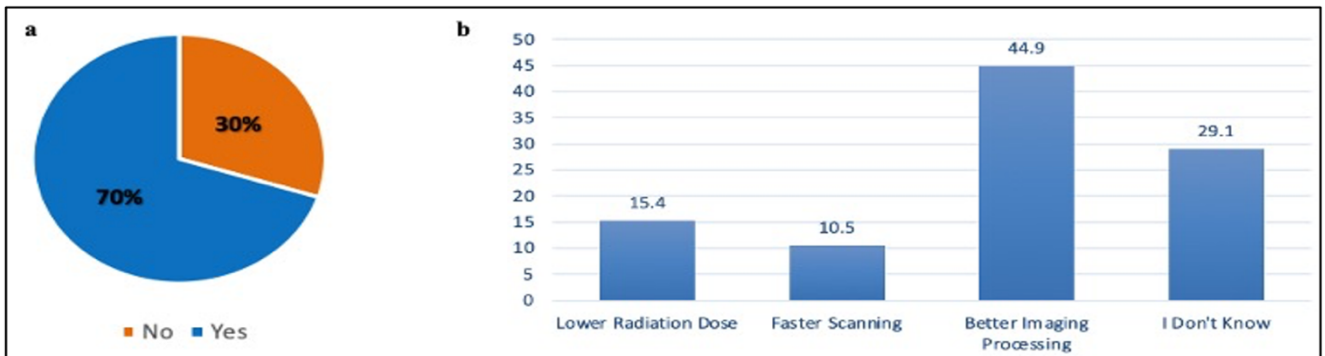


Figure 1. Percentage of participants aware of (a) CBCT technology (b) advantages of CBCT over traditional diagnostic images.

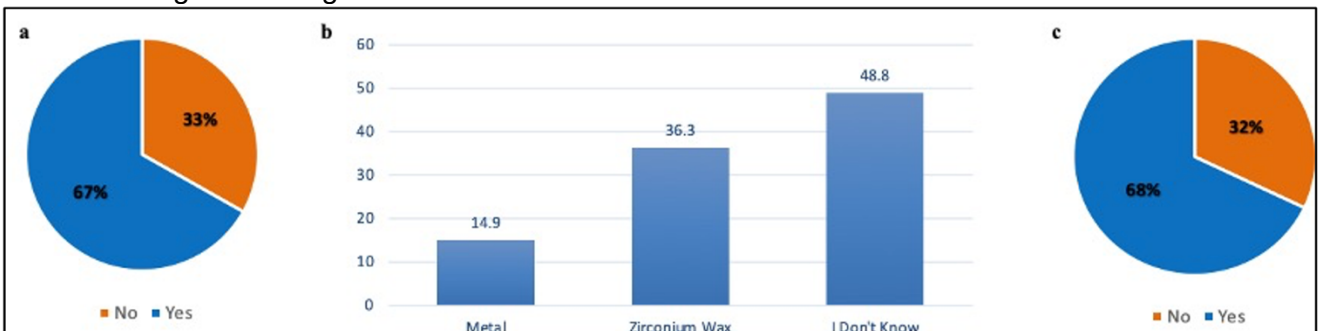


Figure 2. Percentage of participants aware of the (a) digital technology CAD/CAM, (b) materials used with CAD/CAM technology, (c) aware that complete dentures can be manufactured using CAD/CAM technology.

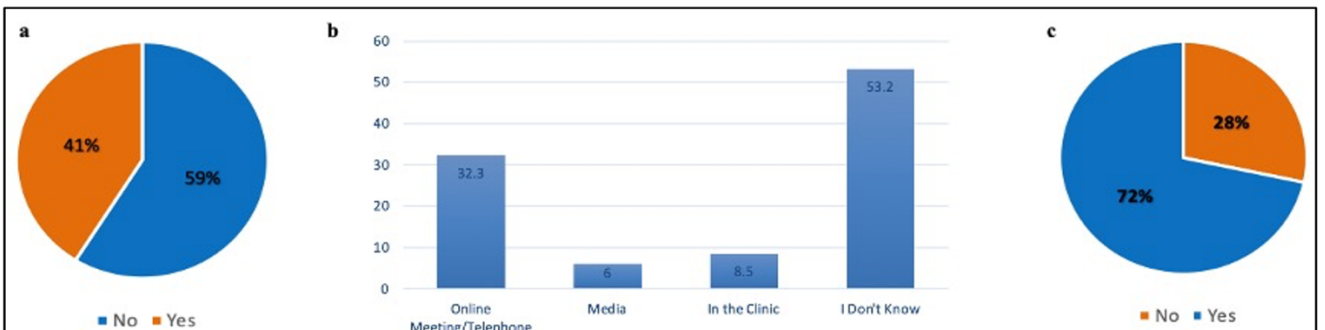


Figure 3. Percentage of participants aware of (a) tele-dentistry (b) modes of using tele-dentistry (c) choosing tele-dentistry for good oral hygiene training.

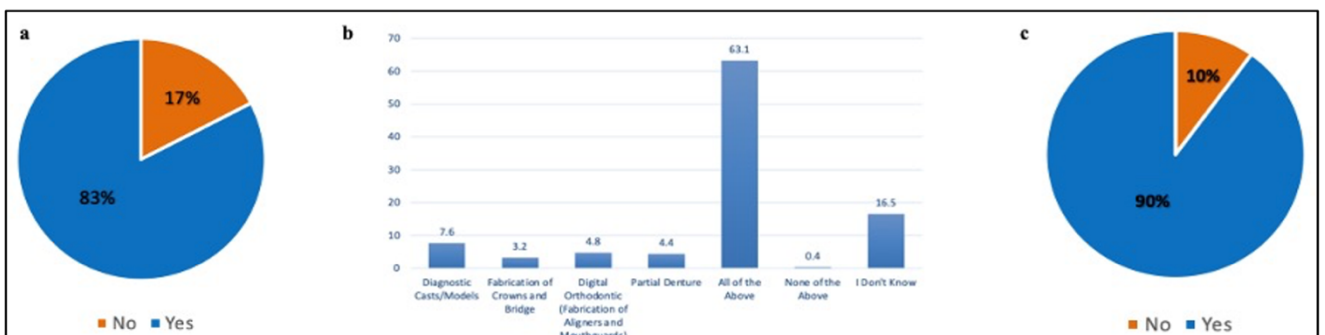


Figure 4. Percentage of participants aware of (a) use of 3D printing in dentistry (b) possible applications of 3D printing in dental practice and (c) digital dentistry improving the quality of treatment.

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