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Perception, awareness, and attitude toward digital dentistry among pre-dental students: an observational survey

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Abstract

Background: Pre-dental students' perception and awareness about current technology in dentistry can influence their motivation and maturity during the learning experience and affect their dental education outcome. This observational survey aimed to examine pre-dental student's cognitive and behavioral traits as perception measures toward digital dentistry. The survey covered areas that the authors believed to impact dental education and future investments in institutional decision-making. The survey was distributed over all predental students representing two US dental schools in the state of Kentucky. The survey included four main categories: (1) Career vision, (2) Perception of digital dentistry, (3) Prior knowledge of digital dentistry, and (4) Personal intelligence.

Results: The feedback was positive toward the future use of digital dentistry. The findings are discussed in light of the implications of pre-dental students' perception to support teaching and learning in dental education.

Conclusions: Despite the expected enthusiasm of pre-dental students toward digital technology, the results highlight the need to emphasize structured self-learning, self-evaluation, and a deeper understanding of research within the dental curricula.

Keywords: Perception, Awareness, Attitude, Digital dentistry, Pre-dental

Background

The profession of dentistry is continuously improving and becoming more innovative in many aspects. The sheer breadth of the new digital technologies in the dental practice workflow positively impacts dental care quality and patient satisfaction (Fasbinder 2012; Nassani et al. 2021). Revolutionary digital equipment has been introduced to the field of dentistry, including cone-beam computed tomography (CBCT), 3D intraoral and facial scanners, 3D printers, and integrated processing software, such as the computer-assisted design/

computer-assisted-manufacturing (CAD/CAM) prosthetic software and dental implant planning software (Jacobs et al. 2018). The introduction of these recent techniques, together with the pivotal advances in dental materials, are transforming the entire field of dentistry (Abduo and Lyons 2013; Bayne et al. 2019; Mangano et al. 2016; Richert et al. 2017; Spector 2008).

The digitization of the dental profession offers advantages that combine analog workflows with recent digital technologies. The main clinical advantage of their use is the enhancement of the perceived and measured quality of care. Digital dental applications can support dentists in making the most accurate diagnostic-based decisions (Tallarico 2020). For example, intraoral scanners allow tooth preparations to be viewed in a high contrast magnified field on a computer monitor and often directly at the

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patient's sight. This permits real-time modifications and precise aesthetic/functional-driven planning for the restoration and improves the quality of the provided dental treatments (Mangano et al. 2017) The widespread adoption of electronic patient records that emanated from the use of intraoral scanners and contemporary digital imaging techniques brings many advantages to dentistry, including improved communication between the dentists, patients, dental laboratory technicians, as well as third-party stakeholders, more outstanding quality and data archiving, and improved patient experiences (Delrose and Steinberg 2000).

Despite the many benefits of the application of digital technologies, several factors influence their adoption in dentistry. The lack of knowledge and skills is one of the most important factors limiting technology's efficient integration and utilization in dentistry (Matthews et al. 2016). Therefore, many dental schools in the US have started to incorporate the most recent digital technologies in their curricula to provide students with the knowledge and skills necessary to keep pace with the rapidly growing need for the implementation of digital techniques and workflows in dentistry (Gratton et al. 2016; Schlenz et al. 2020; Kutkut and Okeson 2022; Siegel et al. 2019; Afshari et al. 2017; Ishida et al. 2022; Prager et al. 2020, 2022; AlKindi et al. 2018; Jurado et al. 2021).

There is a lack of literature regarding pre-dental student's knowledge of digital dentistry before applying to dental schools. Given the increasing interest in technology mainly driven by industry, it is essential to explore whether pre-dental students' knowledge and expectations of digital dentistry are current with the continually updated dental curricula. Understanding pre-dental students' perception and awareness of digital dentistry are vital in influencing institutional admission processes and decision-making regarding resource investment. Moreover, an exploration of pre-dental students' current knowledge and experiences in digital dentistry will significantly adjust pedagogical methods, research collaboration, and future dental practice. This survey primarily aimed to measure the level of perception, awareness, and attitude toward digital dentistry in pre-dental students.

Methods

The education systems in the USA and Europe are different. In Europe, students enroll in dental school after graduating from high school, usually at 18–20 years. This study included pre-dental students enrolling in Bachelor's Degree Programs at different years of study, i.e., Freshman (1st year), Sophomore (2nd year), Junior (3rd year), Senior (4th year), and Post-Graduate students enrolling in Masters Degree Programs. The age range was 18–26 years old. The method adopted was an anonymous

and voluntary survey distributed over 75 predental students representing the University of Kentucky and the University of Louisville. The survey instrument was designed to assess pre-dental students' perception, awareness, and attitude toward digital dentistry. The survey was accessed online through "SurveyHero", a web-based survey and evaluation tool, with a link provided to participants in an e-mail invitation. The survey was offered for 2 weeks in July 2017. All the participants provided an electronic written informed consent before starting the survey. The survey was divided into four categories: (1) Career vision, (2) Attitude of digital Dentistry, (3) Prior Knowledge to Digital Dentistry, and (4) Personal intelligence and attitude toward dentistry. The first category included details about the current involvement in the dental field and their vision as future dentists. The second category reflected the student's perception of digital dentistry. The third category provided an insight into student attitudes toward the usage of digital dentistry and revealed students' prior knowledge of digital dentistry. The fourth category incorporated questions about the reason(s) for choosing dentistry as a future career and what was/were their inspiration. Participants were allowed to select more than one option in the fourth category. All participants completed the survey anonymously using the browser and device of their choice and a place and time convenient for their schedules. To assure the anonymity of the study, no computer Internet Protocol (IP) addresses were collected, and the investigators had no way of identifying the participating students.

Results

The survey targeted all predental students from two US dental schools in Kentucky, of which 44% responded. The grade level for the participants was distributed as the following: Freshman 21.2%, Sophomores 15.2%, Juniors 30.3%, Seniors 24.2%, and 9.1% post-graduates (Table 1). In the first survey category, the students assessed their current dental field activities and their future vision as dentists (Table 2). Predental students were primarily involved in studying and volunteering, followed by shadowing and campus involvement. Most

Table 1 Student level in the undergraduate/graduate programs

Class level	%
Freshman	21.2
Sophomore	15.2
Junior	30.3
Senior	24.2
Post-graduate	9.1

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Table 2 Students awareness for career vision

Do you see yourself using digital dentistry in your future career?	
Yes	97%
No	3%
Which of the following are you primarily involved in?	
Campus extracurricular activities	69.7%
Shadowing	69.7%
Volunteering	78.8%
Studying	87.9%
Select all that apply: which of the following do you see yourself being involved in as a dentist?	
Research involvement	21.2%
Private practice	94.0%
Faculty member	36.4%
Attending continuing educational seminars	30.3%

pre-dental students (97%) thought they would use digital dentistry in their future careers. As prospective dentists, 94% of the participants saw themselves in private practice, whereas 36.4% were engaged in academia as faculty members. Of all participants, 30.3% considered attending continuing education seminars postgraduation. The slightest interest was in research, as 21.2% of the participants indicated that they wanted to be involved in research in the future.

In the second category, the students were evaluated regarding their perception and awareness of digital dentistry (Table 3). The second category of the survey indicated that 93.8% of students considered that digital dentistry would provide more precise results than conventional dentistry. Students were asked about the meaning of the acronym CAD/CAM, a term frequently used since the beginning of digital dentistry. Of all participants, 65.6% responded correctly as Computer-Aided Design and Computer-Aided Manufacturing. All of the participant predental students believed that digital dentistry would revolutionize the workplace. Among participants, 51.5% stated that they had no prior knowledge of Digital Dentistry. On a scale of 1–10, with (0–4) being beginner, (5–7) being skilled, and (8–10) indicating a proficient, 48.5% of the participants considered themselves as proficient in using technology. In comparison, 45.5% thought of themselves as skilled, and 6% felt like beginners. When asked on a scale of 1–10 about how much digital dentistry has improved the work efficiency in the lab; with (0–5) decreasing efficiency, (6–8) being no difference, and (9–10) increasing efficiency, 42.4% of the participant believed that digital technology would increase the efficiency of the lab work, 45.5% the participant thought that it wouldn't make any difference in work efficiency. In comparison, 12.1% believed that it would decrease the efficiency of the lab work.

Table 3 Students' perception of digital dentistry

Does digital dentistry provide more precise results than conventional dentistry?	
Yes	93.8%
No	6.2%
What does CAD/CAM stand for?	
Computer-aided design and computer-aided manufacturing	65.6%
Computer-aided dentistry and computer-aided medicine	21.9%
Computer-analyzed dentistry and computer-analyzed medicine	9.4%
Computer-adapted dentistry and computer-adapted medicine	3.1%
Do you see digital dentistry revolutionizing the workplace?	
Yes	100%
No	0%
Do you have any prior knowledge of digital dentistry?	
Yes	48.5%
No	51.5%
Do you consider yourself skillful in using technology?	
0–4: Beginner	6%
5–7: Skilled	45.5%
8–10: Proficient	48.5%
How much do you think digital dentistry has improved work efficiency in the lab?	
0–5: Decreases efficiency	12.1%
6–8: No difference	45.5%
9–10: Increases efficiency	42.4%

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The third category of the survey aimed to assess the students' prior knowledge of digital dentistry (Table 4). When asked how many dental schools in the US include digital dentistry in their curricula, 51.6% chose less than five US dental schools, 45.2% chose 5–15 US dental schools, and 3.2% chose more than 16 US dental schools. When asked which dental field you think utilizes digital dentistry the most, 46.9% of students chose General Dentistry, 25% chose Oral Maxillofacial surgery, 18.8% of students chose Prosthodontics, and 9.4% of students chose Periodontics. The survey results also revealed that 63.6% of the participants thought there would be no decline in a patient's quality care using digital dentistry. In comparison, 21.2% believed that anything computerized loses the personal human touch or interaction. When the students were asked to estimate the amount of studying in dental school, 9% indicated that amount of studying ranges from 30 to 40 h, 51.5% indicated that the range is from 40 to 60 h, 15.2% indicated that the range is from 50 to 70 h and 30.3% indicated that the range is from 70+ h.

Students were asked about considering dentistry as a future career (Table 5). Most of the participates (84.8%) were persuaded by a dentist, 69.7% chose dentistry because of the life-work balance, 60.6% chose dentistry due to financial security, 15% chose dentistry because it is a family career, and 6.1% had other reasons. Moreover, the students were asked about their inspiration for choosing dentistry (Table 5). Most of the students (69.7%) were influenced by shadowing, the family dentist inspired 57.6%, 45.5% were affected through volunteering, and 3% were inspired through workshops.

Table 5 Personal intelligence and attitude towards dentistry

Why are you considering dentistry as your future career?	
Financial security	60.6%
Work-life balance	69.7%
Inspired by a dentist	84.8%
Family career (family member dentist)	15.2%
Other	6.1%
What has inspired you to pursue dentistry as your career?	
Shadowing	69.7%
Volunteering	45.5%
Family dentist	57.6%
Workshop	3.0%
None of the above	21.2%

Discussion

To the best of the authors' knowledge, this is the first observational survey in the recent literature exploring the pre-dental students' attitudes and perceptions towards digital dentistry. Digital dentistry has brought about so many changes in the last few years that everyone working in dentistry looks at the future with excited anticipation. Due to the ongoing technological trends that influence the general population, there is an increasing need to gauge the breadth and depth of dental applicants' knowledge and attitude toward digital dentistry. This can be valuable to adjust educational tools accordingly.

Unsurprisingly, 97% of the participants expected to use digital dentistry in the future. This is expected to predict digital technology's interest, especially from a "digital

Table 4 Prior knowledge to digital dentistry

How many dental schools in the US do you think to include digital dentistry in their curricula?	
< 5 Dental Schools	51.6%
5–15 Dental Schools	45.2%
> 16 Dental Schools	3.2%
Which dental field do you think utilizes digital dentistry the most?	
General Dentistry	46.9%
Oral and Maxillofacial Surgery	25%
Periodontics	9.4%
Prosthodontics	18.8%
Do you think that there will be a decline in the quality of patient care using digital dentistry?	
Yes, anything computerized loses the personal human touch or interaction	21.2%
Not at all	63.6%
Not if used in all steps	27.3%
How many hours/weeks do you think you will be studying in dental school?	
30–40 h	9.0%
40–60 h	51.5%
50–70 h	15.2%
70+ h	30.3%

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savvy" generation. The remaining 3% who did not expect to use digital technology may indicate that they have a clear vision of the circumstances of the type of practice they will be joining as providers. It may also be due to a lack of awareness of digital dentistry or distrust in technology (Schlenz et al. 2020). To get insight into the type of lifestyle during this stage of education, the students were asked about their current professionally related activities. Expectedly, many participants indicated spending their time studying followed by volunteering, whereas shadowing and campus extracurricular activities were reported less than the former. Shadowing improves students' knowledge of the various techniques used in the field, including digital dentistry (Wanchek et al. 2017). This might also explain why some students do not see themselves using digital dentistry in the future. According to a recent study, pre-dental students believe their service experience, research, and leadership are the most critical dental school application areas (Hawley et al. 2008). An increase in involvement in these areas might be due to the students' preconceived ideas about the dental school applications. This may also indicate that pre-dental students are highly prepared and have a decent knowledge of the growing trends in the dental field. An unexpected yet concerning observation is that only 30% of the students indicated their plans on attending continuing education (CE) seminars. These results indicate a possible poor understanding of the educational process and lifelong learning as an essential tool to keep up with the rapidly changing and evolving dental sciences. In addition, these results may indicate a lack of knowledge regarding the general requirements to maintain dental practicing credentials. Taking a more in-depth look at this trend may be concerning as many students have a misconception that the practicing degree is the ceiling for their education. This emphasizes the need to teach critical thinking skills during dental school to maintain healthcare provider curiosity to continue lifelong learning after dental education. Similarly, another ongoing concerning yet expected result is the low interest in research activity. Both critical thinking and understanding of research are fundamental requirements of the Commission of Dental Accreditation (CODA) (Everett et al. 2018).

Understanding that the dental field is only a clinical service field is an unfortunate point of view. It may indicate a poor understanding of the general population of the depth of the dental field. It might also be an indicator of a lack of knowledge of the importance of research. This is a highly critical debate, as faculty members need to have considerable experience in research to convey this concept to dental students and have them involved in research during dental education. This area is tightly related to the influence of social media and consumer trends. The marketing industry is taking maximum advantage of social media, which in turn impacts education (Appel et al. 2020; Oakley and Spallek 2012). Considering the rapid growth in digital technology, dental education needs to stay current with these trends to properly assess and deliver well-grounded dental education. Therefore, evidence-based dental education and critical understanding of scientific literature at a novice level are becoming more crucial than ever before (Moreira et al. 2018). On the contrary, there was a surprisingly high interest in pursuing an academic career. Unfortunately, this number is inflated compared to reality. This enthusiasm may change after dental school experience or after few years of pursuing a faculty career in the dental field (Chmar et al. 2008).

In the second category, the students were asked questions exploring their perception and awareness of digital dentistry to evaluate if they have adequate and dated information before entering the profession. The results showed that most of the pre-dental students knew the definition of CAD/CAM. This is expected as the commercialization of advanced technology in dentistry ought to keep an informed audience, including consumers. Most of the pre-dental students considered themselves skillful when it comes to technology. This can be expected from generations who perceive themselves as digital-savvy and have high confidence compared to older generations (Wilson et al. 2014). This perceived confidence can be advantageous to the educational process as it allows improved performance, especially when learning new techniques. More than half of the pre-dental students stated they have no prior knowledge of digital dentistry. However, many students believe that digital dentistry provides more accurate results than conventional dentistry. This indicates the willingness to learn new technologies and use them as trusted methods to deliver healthcare.

Furthermore, more than half of the pre-dental students did not assume that digital dentistry improves work efficiency in the lab. This can be due to lack of a deep understanding of technology distracted by the excitement of merely using a new digital tool. Unfortunately, many dental providers fall into this trap, as they become collectors of tools to attract customers and rely on salespeople to educate them to use the new technologies. This trend can be a significant threat to dental education. A good understanding of technologies allows proper decision-making regarding individualized delivery of dental care rather than using technology as a goal by itself. To protect dental education from the marketing industry, more emphasis should be placed on training the dental educators and their staff on emerging technologies. In addition, another priority should be placed on implementing this

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type of knowledge in the curricula of pre-dental courses and workshops.

During the last few years, both the capacity to educate dental students and the interest in studying dentistry by prospective students have increased (Wanchek et al. 2017). The students were asked about their expectations about the number of dental schools, including digital dentistry. In this survey, 51.6% of the students thought that only less than 5 schools are including digital dentistry in their curricula. This indicates that the advancements in dentistry are not a significant factor in the students' decision to apply to dental school. It may also indicate a lack of trust in institutional curricula in keeping pace with evolving technology. Most students believed that the dental field utilizes digital dentistry the most in General Dentistry and Oral Maxillofacial Surgery. A possible explanation for this might be the students' clinical shadowing and volunteering experience influencing their understanding. Another explanation could be the limited understanding of dental specialties at this level of education. Students were asked to estimate the number of hours they spend studying every week to evaluate the time organizing skills, which is crucial for professional success. More than half of the students expected to spend 40–60 h a week studying, which is an appropriate assumption. The results of this sample also indicated that students were drawn to dentistry for several reasons. The primary factor was the influence of the dentist—that might be a friend, an acquaintance, or a family member, followed by the work-life balance and the financial security. The encouragement provided by those practicing dentistry daily can make the predental student presume satisfaction among these professionals in all aspects. In addition, the impact of the dentist's encouragement is more significant if the dentist is a family member (Hawley et al. 2008). The survey results also showed that shadowing in dental practices and treatment institutes is an effective way to increase the prospective dental students' desire to pursue dentistry and attend the host school. In addition, it is a helpful tool to improve dental knowledge and reinforce the focus on practice occurring at an early stage of dental studies (Heitkamp et al. 2018). This also can help the dental schools to improve their applicant pool and enhance the image of the dental school among applicants who are considering applying to it.

The purpose of this study was to address the lack of literature about pre-dental students' prior knowledge regarding digital dentistry. It provides valuable information for dental educators to project future trends in dental schools and practices and improve teaching modalities and the admission process. Keeping in mind the limitations of survey studies being influenced by demographics individual subjectivity related to the phrasing of each question. A more comprehensive survey including pre-dental students and first-year dental students can be helpful to have a comparison between the knowledge gained through a short period and may reveal where the misconceptions may still be to be addressed.

Conclusions

The findings of this survey study indicate a positive attitude toward digital dentistry and enthusiasm for learning emerging technologies in the dental field. This enthusiasm can encourage a positive learning experience, facilitate new pedagogical methods, and embrace future dental educators. However, there is a need for the dental curriculum to highlight the importance of critical thinking, self-learning, and understanding research.

Declarations

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