Knowledge and Perception regarding Digital Dentistry among Saudi Dental Students

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Abstract

The objective of this study was to investigate the usage of digital technologies by dental students in Saudi Arabia and improve dental education outcomes. At random, electronic surveys were distributed to Saudi dental students. Eight hundred sixteen completed questionnaires were returned, with sixteen incomplete questionnaires not analyzed. The questionnaire requested information on gender, age, and level of study, and participation in the study was completely voluntary. Students were asked to complete the questionnaires based on their observations and experiences. Descriptive statistics such as numbers and percentages were used to analyze the collected data. The Chi-square and Fisher's Exact tests were used to assess the results. Among 778 students, 758 (97.43%) had an idea about digital dentistry; however, only 20 (2.6%) did not know about digital dentistry. Intern and clinical students revealed higher knowledge levels than preclinical students ($p < 0.01$). The majority of the students, 715 (91.9%), get knowledge from college.

Regarding digital dentistry during clinical practice, the majority, 677 (87.0%), of the subjects answered yes; however, 101(13.0%) said no. For digital technology use, the majority, 695 (89.3%) of the issues, answered that digital dentistry is helpful in diagnosis; however, only 79 (10.2%) thought that digital dentistry could achieve clinical treatment. The majority of the 766 individuals (98.5%) believed that digital dentistry improved the quality of dental procedures. The majority of students, 737 (94.7%), said that digital dentistry would eventually replace traditional dental services. Regarding higher learning outcomes and the need for skill and training, most sample 765 (98.3%) replied yes to both questions. It can be concluded that students have good knowledge about digital technology, which may have motivated them to practice.

Introduction

In recent years, digital technologies have grown in popularity, and they now play a critical role in the advancement of dentistry.[1] Computer-aided design and computer-aided manufacturing (CAD/CAM) technology is a cutting-edge digital system that can scan prepared teeth for crowns, bridges, inlays, and other restorative restorations.[2] Furthermore, communication and access to information in dentistry are becoming increasingly computer-aided, digital radiology and photography.[3] They have become common in diagnosis and dental treatments fundamentally based on digital processes such as impression taking, treatment planning, and implant surgery.[3]

Technology plays an increasingly important role in driving innovation and shaping the student experience in today's dentistry education.[1] Understanding educational methodologies are critical to maximizing educational effectiveness as learning methods and tools advance.[4] Virtual anatomy, haptic feedback tools, and improved digital charting methods are just a few of the innovations that have the potential to improve pre-clinical education efficiency.[1] Traditional laboratory techniques such as waxing, casting, finishing, and tooth preparation exercises on the phantom head (simulation unit) are still used in most

universities to educate dental students. [5] As a result, the challenge was to implement new digital technologies, such as computer-aided learning (CAL), without neglecting the importance of manual skills training in dental treatment.[5] Simulation systems and digital haptic have evolved into valuable tools for teaching dental-related skills.[6] Teaching insight into dynamic occlusion, finding cephalometric landmarks, tissue compliance in surgery, and drilling for implant placement have benefited from real-time input via tactile sensation.[7] Students can better comprehend anatomical relationships that are difficult to detect in real life by using three-dimensional (3D) virtual models.[8] Additionally, dental procedures and patient management can benefit from robot-based simulation systems that can be programmed to model a variety of physiological circumstances.[9] Since schools struggle with a shortage of professors, haptic systems become more attractive as they reduce the need for instructor supervision.[10] Though both are beneficial, education is enhanced by combining professor and virtual-reality feedback, rather than substituting one for the other.[7]

Apart from mentioned benefits, digital technology poses significant challenges in terms of curriculum management, and the overlap of analog and digital educational objectives necessarily requires adaptation.[1] The incorporation of digital technologies into dental education systems began globally and has progressed at different rates based on local resources and demands.[11] With the integration of multiple dental disciplines, 3D education programs have been introduced to help students improve their spatial ability, interactivity, critical thinking, and clinical correlations. Overall, digitalization appears to have significantly impacted dental education, addressing various aspects such as e-learning and web-based knowledge transfer.[11] Moreover, digitalization plays a role in diagnostics using 3D imaging and digital radiography, and practical oriented training in dental simulator motor skills, including intraoral scanners (IOS) with 3D printing, prototyping, and digital surface mapping.[11]

Students may need more computer programming knowledge to support evidence-based decision making and to fully discover the required information in the age of big data and analytics, and thus will need to take computer courses.[1] Throughout this way, digital technology could become a desired educational goal and competence that will eventually replace other parts of the curriculum.[12] Additional concern is that students' patient engagement skills may decrease if they prefer interacting with technology more than with patients, professors, and classmates. Another worry is that students may be lacking the manual dexterity needed to conduct dental treatments at stated proficiency levels utilizing analog techniques.[12] Finally, potential social injustice may arise due to low socioeconomic societies' inability to achieve technological advancements in education.[12]

Digital technologies usage in dentistry has been a focus of many researchers due to its importance in future practice. For this reason, it is crucial to conduct a study in digital technologies usage among dental students in Saudi Arabia to investigate the current situation and fill the knowledge gap in the critical area and give starts for further investigations. Furthermore, a scientific study is required to help academicians determine the current situation and improve the future outcomes regarding this critical area to modify the

curriculum accordingly. This study aimed to investigate the usage of digital technologies by dental students in Saudi Arabia and improve the dental education outcomes.

Materials And Methods

A cross-sectional study was conducted among Saudi dental students. The estimated sample size for the study was 750, determined by the OpenEpi® sample size calculator, considering P=5%, power of 84%. The Ethical Committee of the University of Hail approved the study, and the subject of anonymity was strictly respected.

A pilot survey with a convenient sample of 20 dental students was conducted using a self-administered structured questionnaire with 12 questions. The questionnaire requested information on gender, age, and level of study, and participation in the study was completely voluntary. Students were asked to complete the questionnaires based on their observations and experiences. Furthermore, the questionnaire did not require any changes based on their feedback. The electronic questionnaires were sent out randomly to Saudi dental students.

Inclusion criteria

1. Saudi nationality
2. Dental Students

Exclusion criteria:

1. Subjects with non-dental education
2. Subjects who are non-Saudi.

A total of 816 completed questionnaires were returned, with sixteen incomplete questionnaires not analysed. Completed questionnaires were coded in Windows Excel and statistically analysed using Statistical Package for the Social Science Software version 28 (IBM SPS Statistics). Descriptive statistics such as numbers and percentages were calculated for the collected data. Frequencies, Crosstabs, Chi-Square, and Fisher's Exact tests were used to determine the significance of gender and study level differences in the perception and knowledge of digital dentistry among Saudi dental students.

Results

A total of 778 participants answered the questionnaire. Among participants, females were 476 (61.2%), and males were 302 (38.8%). The highest number of subjects, 51 (66.2%), were clinical students, followed by intern 209 (26.9%) and preclinical students 54 (6.9%).

The distribution of questions and scores related to the knowledge of digital dentistry is as shown in Table 1, while Tables 2 and 3 display the influence of gender and study level on the understanding of

digital dentistry. Among 778 students, 758 (97.43%) had an idea about digital dentistry; however, only 20 (2.6%) did not know about digital dentistry. There were no significant differences between men and women regarding ideas about digital dentistry ($p > 0.05$), as shown in Table 2. Intern and clinical students revealed higher knowledge levels than preclinical students ($p < 0.01$), as shown in Table 3. The majority of the students, 715 (91.9%), get knowledge from college. There were statistically significant associations between gender and field of study ($p < 0.05$).

Table 1
Distribution of the Responses to the Knowledge of digital dentistry

Variable		Response n (%)
Idea digital dentistry	Yes	758(97.4)
	No	20(2.6)
Yes specify	College	715(91.9)
	Textbook and articles	28(3.6)
	Internet	22(2.8)
	Conference	11(1.4)
Use digital	Yes	677(87.0)
	No	101(13.0)
Digital technology useful	Diagnostic satisfaction	695(89.3)
	Clinical treatment achieved	79(10.2)
Digital improve	Patient satisfaction	13(1.7)
	Quality of treatment achieved	15(1.9)
	Time-saving	6(0.8)
	Improved accuracy in comparison to previous	4(0.5)
	High level of predictability of outcome	6(0.8)
	More than one	734(94.3)
Digital improve quality compared to traditional	Yes	766(98.5)
	No	12(1.5)
Replace traditional	Yes	737(94.7)
	No	41(5.3)
Better learning outcomes	Yes	765(98.3)
	No	13(1.7)
Require skills and training	Yes	765(98.3)
	No	13(1.7)

Table 2
Influence of gender responses of the participants about digital dentistry

Variable		Gender		P-value
		Male	**Female**	
Idea digital dentistry	Yes	291(96.4)	467(98.1)	0.060
	No	11(3.6)	9 (1.9)	
Yes specify	Collage	273(90.7)	442(93.1)	0.015
	Textbook and article	9(3.0)	19(4.0)	
	Internet	14(4.7)	8(1.7)	
	Conference	5(1.7)	6(1.3)	
Use digital	Yes	250(82.8)	427(89.7)	0.002
	No	52(17.2)	49(10.3)	
Digital technologies useful	Diagnostic	261(87.3)	434(91.4)	0.019
	Clinical	38(12.7)	41(8.6)	
Digital improve	Patient satisfaction	4(1.3)	9(1.9)	0.022
	Digital improve	4(1.3)	11(3.2)	
	Time saving	4(1.3)	2(0.4)	
	Improved accuracy in comparison to previous	1(0.3)	3(0.6)	
	High level of predictability of outcome	2(0.7)	4(0.8)	
	More than one	287(95)	447(93.9)	
Digital improve quality compared to traditional	Yes	294(97.4)	472(99.2)	0.035
	No	8(2.6.)	4(0.8)	
Replace traditional	Yes	283(93.7)	454(95.4)	0.077
	No	19(6.3)	22(4.6)	
Better learning outcomes	Yes	297(98.3)	468(98.3)	0.225
	No	5(1.7)	8(1.7)	
Require skills and training	Yes	298(98.7)	467(98.1)	0.196
	No	4(1.3)	9(1.9)	

Table 3
Influence of study level responses of the participants about digital dentistry

Variable		Study level			P-value
		Pre-clinical student	clinical student	Intern	
Idea digital dentistry	Yes	46(85.2)	507(98.4)	205(98.1)	0.001
	No	8(14.8)	8(1.6)	4(1.9)	
Yes specify	Collage	41(77.4)	485(94.4)	189(90.4)	0.026
	Textbook and article	5(9.4)	14(2.7)	9(4.3)	
	Internet	4(7.5)	10 (1.9)	8 (3.8)	
	Conference	3(5.7)	5(1.0)	3(1.4)	
Use digital	Yes	28(51.9)	475(92.2)	174(83.3)	0.007
	No	26(48.1)	40(7.8)	35(16.7)	
Digital technologies useful	Diagnostic	40(75.5)	479(93.4)	176(84.6)	0.068
	Clinical	13(24.5)	34(6.6)	32(15.4)	
Digital improve	Patient satisfaction	0(0.0)	10(1.9)	3(1.4)	0.024
	Treatment Quality	4(7.4)	5(1.0)	6(2.6)	
	Time saving	1(1.9)	3(0.6)	2(1.0)	
	Improved accuracy in comparison to previous	0(0.0)	0(0.0)	4(1.9)	
	High level of predictability of outcome	3(5.6)	3(0.6)	0(0.0)	
	More than one	46(85.2)	494(95.9)	194(92.8)	
Digital improve quality compared to traditional	Yes	51(94.4)	511(99.2)	204(97.6)	0.208
	No	3(5.6)	4(0.8)	5(2.4)	
Replace traditional	Yes	41(75.9)	501(97.3)	195(93.3)	0.013
	No	13(24.1)	14(2.7)	14(6.7)	
Better learning outcomes	Yes	48(88.9)	510(99.0)	207(99.0)	0.001
	No	6(11.1)	5 (1.0)	2(1.0)	
Require skills and training	Yes	47(87.0)	510(99.0)	208(99.5)	0.000

	No	7(13.0)	5(1.0)	1(0.5)

Regarding digital dentistry during clinical practice, the majority, 677 (87.0%), of the subjects answered yes; however, 101(13.0%) said no. There were statistically significant associations between digital dentistry and the relative factors ($p < 0.05$), as shown in Tables 2 and 3. Women and clinical students had higher digital dentistry use than men and either intern or preclinical students, respectively.

For digital technology use, the majority, 695 (89.3%) of the subjects, answered that digital dentistry is useful in diagnosis; however, only 79 (10.2%) thought that clinical treatment could be achieved by digital dentistry. There were statistically significant differences between genders ($p < 0.05$). however, there were no statistically significant differences regarding the level of study of dental students ($p > 0.05$).

Figure 1 shows how digital dentistry improves clinical practice. Most responses gave more than one answer. There were statistically significant relations between gender and field of study ($p < 0.05$).

For digital to outperform conventional in terms of quality, the majority of the 766 individuals (98.5%) believed that digital dentistry improved the quality of dental procedures. There were statistically significant gender differences ($p < 0.05$). There were, however, no statistically significant variations in the level of the study of dental students ($p > 0.05$). The majority of students, 737 (94.7%), said that digital dentistry would eventually replace traditional dental services. There were statistically significant variations in study levels ($p < 0.05$). However, there were no statistically significant gender differences among dental students ($p > 0.05$).

In terms of higher learning outcomes and the need for skill and training, most sample 765 (98.3%) replied yes to both questions. There are no statistically significant differences between genders regarding superior learning outcomes and skill and training requirements ($p > 0.05$). However, there were statistically significant relationships ($p > 0.05$) for the study level.

Discussion

Digital simulation technologies have already been included in dental curriculums in a number of countries for undergraduate students. Digital microscopes, virtual pathology slides, digital X-ray images, digital dentistry skill training machines, and digital assessment systems are just a few of the simulation technologies available. However, dental schools are facing a number of issues as they integrate digital dentistry into their regular curriculums. To operate advanced technologies, a large number of people must be thoroughly and efficiently trained. The digital software must connect easily with existing software, and an internal infrastructure capable of managing huge data inputs must be built. To meet demand, high-volume production in large dental institutions necessitates the cooperation of external laboratories. This outsourcing creates a new issue in terms of secure digital data transfer in conformity with regulating agencies' patient privacy and protection standards. Large dental institutions must be aware of the unique problems they face when attempting to implement a digital workflow. An appropriate infrastructure can

be developed with sufficient preparation and planning, allowing for a smooth and safe transition to the digital era.

Dental education, like other academic areas, has experienced significant changes. Modern oral health education demands the adaptation of instructional techniques that need higher level thoughtful abilities. Gies[13] emphasized the initial necessity for curriculum modification in dentistry schools to "progress instruction". Furthermore, a range of scientific research[14–17] has underlined the need for a pedagogical shift in dentistry education toward a more technologically based curriculum. The academic institutions themselves are seen to be driving this broad interest in curriculum change to increase the quality of oral health instruction for dentistry students. Graduates will be more equipped for a professionally competitive market if education is improved.[14] Baum[15] proposed that various variables, such as altering demographic trends, advancements in medical areas, a tremendous change in offering cutting-edge health care, and economic situations, have influenced the need for an emphasis on curriculum reform in dentistry education.

Digitalization is commonly utilized in dentistry education to improve document accessibility and facilitate cooperation and communication among students, professors, and administrative personnel. It is vital to encourage a shift in the dental faculty's perspective to promote theoretical and practical knowledge transfer to meet these expectations. Even though dental students must now be equipped for digital dentistry, they must still learn about traditional treatment techniques and processes. They will quickly adapt to digital characteristics as they grow up in the digital environment. Digital dentistry provides various opportunities for objective, standardized evaluation of student performance, which should improve quality. It is presently a "teaching transition phase," and new dentistry education criteria must be created in general.[11, 18–20]

Many studies found that digital dentistry has gained in popularity among not only dental educators but also among behavioural, social, and educational professionals.[18, 21] To improve their educational experience and future careers ; therefore dental students are suggested to use the digital technology.[22] Students are immersed in digital dentistry and, as a result, are typically excited and motivated about using technology in their future jobs.[23, 24] However, no studies on students' knowledge about digital dentistry in actual practice have been published in Saudi Arabia. As a result, the current study was designed to measure dental students' knowledge and attitudes about digital dentistry.

According to the findings of this study, students had information in digital dentistry, and most of them learned about it in college. This outcome was unsurprising; meanwhile, it was in line with all prior research describing time as a critical issue for dental school administrators due to the excessive amount of knowledge delivered to students.[25] In this setting, educators have to be conscious of their responsibilities in training new dentists who will be managing persons with unique requests who will require empathy and informed consent for decision in every treatment. Although digital tools and applications in information transmission constitute a usual problem for education in all fields, the area of dentistry, with its large proportion of practical training units, is particularly challenging. Students do not

learn on their own since training modules are developed digitally. The cornerstone to successful dental education remains continuous instruction with supervision and feedback. In this context, digitalization is unquestionably a fantastic chance to deliver learning content with tremendous excitement and newly awakened passion.

According to the findings of this study, students had a favourable approach toward digital dentistry that agrees with prior research.[10, 26, 27] Students' overall behavioural intentions regarding digital dentistry revealed that they are eager to employ it in their future practice.

Females and intern and clinical students revealed higher levels of knowledge than did males and preclinical students. Women and clinical students had higher used digital dentistry than men and either intern or preclinical students. That might be because the level of knowledge gradually increased across the classes, with preclinical students having the lowest level of knowledge and intern and clinical students having the highest level of expertise. Furthermore, that indicates a superior understanding of digital dentistry and relates to a greater intention to utilize digital technology. This pattern is an excellent predictor of student success and development as they progress through their educational experience. Determining shortcomings in perceived training quality relating to faculty, laboratory assistance, lectures, time or might help target future efforts to address some of these exhaustive difficulties.

It stands to reason the students who believe their training to be of high quality have more information than students with lesser training, which may be related to problems in the instruction taken.[19, 20] The research, as mentioned earlier, compared student performance utilizing new digital technology to traditional approaches and polled students on their choices. They proposed that students obtain more knowledge if they believe the instruction is of good quality that significantly affects future education programs in dentistry. According to the present poll, students have a favourable attitude about the usage of digital technology as compared to traditional ways.

Notifying dental students of the degree of technology used during training and emphasizing the value of utilizing technology might influence their willingness to utilize it in the future. Therefore, future attempts to develop dentistry education should focus on elements related to a student's behavioural intention. Enhancing student understanding and views regarding digital dental technology, from the perspective of the dental educator, is critical for students to involve with digital technology in their practice after graduation. Furthermore, utilizing digital technology during dental procedures with relevant experiences using decent equipment with good information and plenty of training time is probable to assist students in developing favourable approaches toward using technology. Again, that might increase the likelihood of using this technology.

Surveys help assess the level of knowledge attained by the practitioners/participants and enable the researchers to reach a wider group of population and assess the awareness, knowledge, and practice of the practitioners, especially regarding the recent advancements in dentistry. The limitations of our survey are that it is confined to a smaller number of respondents, cannot be generalized to a large population.

Because this was cross-sectional research, it merely revealed connections rather than causality. Furthermore, web-based surveys are inaccessible to challenging respondents who may lack access to the survey. Sometimes sampling errors arise due to online surveys, and open-ended questions and responses might lead to interviewer bias. Even though students appear to be driven toward digital dentistry, and findings show that they want to employ the technology in actual training and future practice, it was not examined; this could be highlighted in future research. The study's findings are confined to the demographic studied undergraduate dentistry students. These findings cannot be extrapolated to other groups, but they can help future studies. Differences in technology use for groups with varied characteristics should be considered for future processes of invention and deployment of digital technologies to be acceptable for dentists and their job. Attitudes toward digital technology may further shape these inequalities, which should be investigated more in the future. An enormous population, particularly for a specific speciality/age/experience group of dentists, should be examined in the future.

Conclusions

They were changing and implementing various educational methodologies and training to impact and boost the motivation of the students to employ digital technology in future practice. Under the limitations of this study, it can be concluded that students have good knowledge about digital technology and may have motivated them to their future practice. The students reported that digital dentistry is better than traditional methods during various procedures. Most students reported that digital technology would improve the dental practice learning outcomes than conventional methods. However, the students emphasize that these technologies need more require skills and training. There was a relationship between student knowledge, attitudes, gender, and degree of education and the use of digital dental technologies in their training. The dentistry profession is undergoing fast technological change. It appears fitting that dentistry education adapts to a dynamic shift toward developing digital technology. Dental educators and developers of digital dental technology might benefit from considering these variances and customizing communication and training accordingly. If a technologically upgraded dental curriculum is developed, the dental profession will profit from an outstanding calibre of qualified dentists.

Declarations

Ethics approval and consent participate

The Ethics Committee of Scientific Research, University of Hail, Saudi Arabia, approved the protocol of this study. All methods were performed in accordance with the declaration of Helsinki. (Ethical number: H-2021-145)

Informed consent

Informed consent was waived by the ethics committee of college of Dentistry, University of Hail. (Ethical number: H-2021-145)

Consent for publication

"Not Applicable".

Competing interests

The authors state that they have no conflicting interests.

Availability of Data and Materials

The data that support the results of this study are accessible from the corresponding author upon reasonable request.

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Authors’ contributions

IKA and AAM contributed to the concept of the research, study design, statistical analysis, writing the original draft, and reading and editing the final paper. FLA contributed to the concept of the research as well as revising the first draft. SMA and BBA contributed to data gathering and statistical analysis. The final manuscript was reviewed and approved by all writers.

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Figures

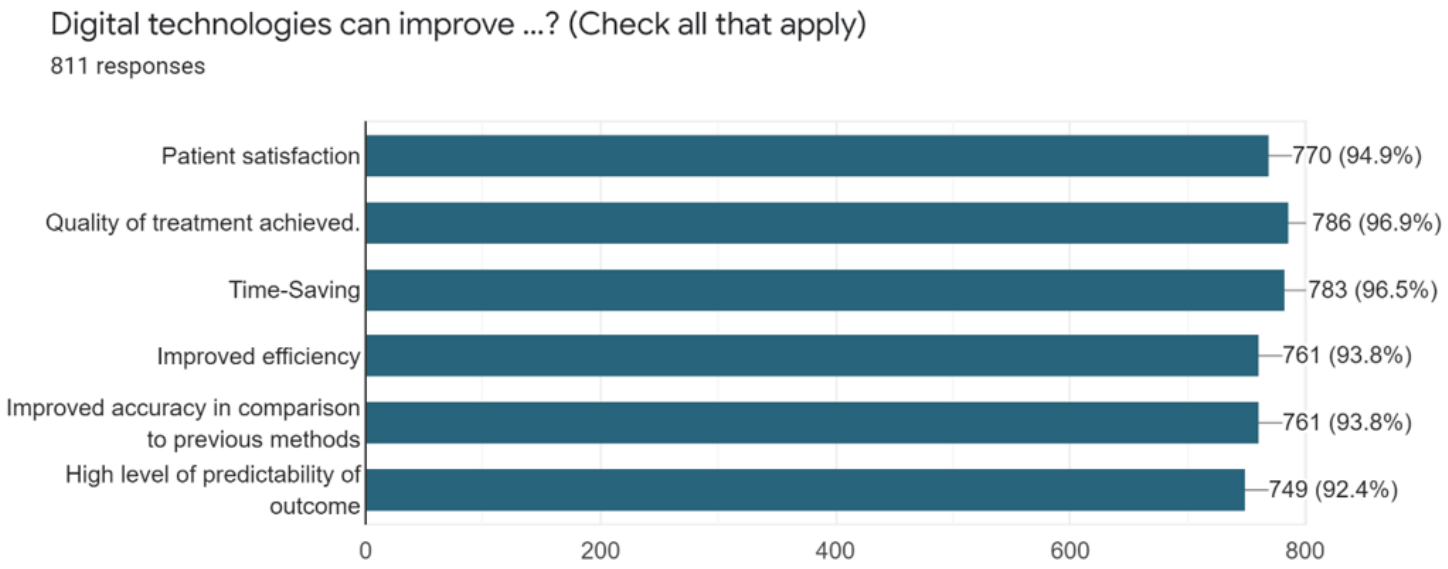

Figure 1

shows how digital dentistry improves clinical practice