

# Digital Management System for Student Training in Educational Dental Clinics

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## Abstract

Studies and research in the health fields have shown that information technology has a significant impact on managing and improving the quality, safety and efficiency of health care. It reduces clinical errors. When we build and customize a database for any system, we allow access to the content and the ease of recalling, managing and updating its data when needed. The project aims to build a database system to store, organize and retrieve data from educational clinics in the College of Dentistry in Iraqi universities. The collected data is used to build the database model and system architecture. The system was developed to provide assistance to college teaching dental clinics in managing and maintaining their database. Data were collected from 5 clinics in various specialties affiliated with the College of Dentistry from various departments in the college, and a unique asset number was allocated to each educational clinic located in the college according to the required standards and for ease of representation. The system is built in C#. SQL Server (Structural Query Language) is used to run user information. The proposed system has the ability to manage and protect a database through a login mechanism for all members working on the system.

*Keywords:* Clinic Management System; database management system; Educational information system

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## 1. Introduction

In light of the change in the world of data, it has become necessary to move from the old traditional methods of data management, which are represented in the use of paper records, to digital data via a computer, which makes the administrative process less effortful and wasteful. At the same time (D. Taylor et al., 2004), and (Muhammad F Walji et al., 2009) there are some institutions that still use traditional methods of data collection and have not been completely digitized, including educational clinics in dental colleges, where paper is still used to collect patient data and supervise Cases through paper records, which makes it difficult to prepare and collect reports on the clinic champion, as well as the difficulty of supervising students in educational clinics and determining the clinical work requirements for each student (Abdul Razak Hussain et al., 2010), and (Al-Samarrai & Jasim, 2023).

Therefore, a system was proposed that provides the administration with ease of supervising the clinical educational process within educational dental clinics, as well as providing the teacher with ease of following up and supervising students trained in clinical work in clinics. On the other hand, the system provides us with the registration of received cases, the complete recording of patient data, the determination of appointments, and the possibility of making any changes to the working hours of each patient. It also provides the necessary reports and the required daily, monthly, and annual statistics, and provides reports on the number of beneficiaries of the services provided by the educational clinics in the college, which is part of the requirements for institutional accreditation and the community service standard (Saleh & Abbas, 2024).

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## 2. Related background

Through previous studies, three systems were selected for comparison , According (Quantum X Inc, 2023) in 2023, (My Dental Clinic) is an application that supports private dental clinics and helps dentists track patient information through the interfaces provided by the application, which are the interfaces for adding patient information, adding appointments, and displaying upcoming appointments. The application is easy to use, but the disadvantages of the application are that the patient cannot set an appointment or request an appointment except by contacting the dental clinic. The application also does not support educational clinics in dental colleges.

In (Picktime, 2023), the (Picktime) application is an application that allows adding appointments for customers and displaying previous appointments, supports electronic payment procedures, and can also share the reservation link with the customer. The application can also create and display financial reports. As for the weak point in the application, it is that it does not allow the customer to access appointment details. Therefore, the application does not allow the customer to modify his appointments, and it also does not support students studying in educational dental clinics.

In (Ho et al., 2024) The system proposed by Sin-Ban Ho1 and others, supports the digitization of private dental clinic management data (DCMD), which provides facilities of dealing with treatment details, updating information, and providing up-to-date data about appointments, but the system does not support student trainees in educational clinics.

Table 1 shows comparisons between the some available systems, the traditional system followed in educational clinics at the College of Dentistry, University of Iraq, represented by the paper system and sometimes the Excel sheet and proposed system. Our proposed system aims to create a database for all workers in educational clinics and patients receiving treatment, in addition to creating a table in the database specifically for students linked to the patient and the teaching supervisor of the case. The system also helps in creating a special electronic case sheet Each patient is received in the clinic, as well as the special appointments for each patient, in addition to the necessary reports about the patients, represented by the number of patients according to several criteria, including age group and type of case. On the other hand, there are special reports for students, representing the number of students entering the clinic, the achievement rate, and the number of patients for each student. Finally, the system provides us with a table that includes the clinics in the college, represented by the oral diagnosis clinic, the dental industry clinic, and dental treatment, Dental surgery, orthodontics and pediatric dentistry.

**Table 1.** Comparison between Some Available Systems and Proposed System

Functions		Available systems			The traditional system followed in educational clinics	Proposed System
		MyDentalClinic	Picktime	DCMD	Ms excel sheets	
<b>Supports educational clinics</b>		<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	√
Create Appointment	student	X	X	X	X	√
	staff	√	√	√	X	√
View Treatment History	student	X	X	X	X	√
	patient	X	X	X	X	√
Reports	staff	X	√	√	X	√
	student	X	X	X	X	√
	patient	√	X	X	X	√
Add Treatment Details	staff	√	X	X	√	√
	student	X	X	X	X	√
Student profile	Staff	√	√	√	X	√
	student	X	X	X	X	√

## 3. System analysis and design

### 3.1. Description of the Main System's Functions and Workflow

Includes basic requirements for the system:

- a. Storing and managing large amounts of data.

- b. Entering the data of both the patient and the clinic staff, including doctors, administrators, and students, as well as entering the cases in the educational clinics.
- c. Establishing relationships between employees and determining their powers in the system by determining their access to data.
- d. Providing locking and data synchronization control mechanisms to ensure that data is not updated simultaneously by two people.
- e. Entering the patient’s data and treatment, as well as choosing the doctor supervising the patient’s condition and the student responsible for treating the patient, managing and setting patient appointments.
- f. After entering all the information related to the system and through the information available within the system, it became possible to obtain daily, monthly and annual reports related to patients, students, and the administrative and educational staff in the clinic.
- g. Archiving all data and producing reports in a digital or printed form.
- h. Calculating the extent to which the clinical requirements of trainee students have been fulfilled for each case.
- i. Providing the system with the ability to expand and develop in the future through the algorithms used and the programming languages used in the system.

### 3.2. System Design

The basic components that were represented in Table [2] were relied upon designing the system; which was designed according to a three-layer algorithm that represents the MVC architecture, which is distinguished by its ability to organize work in the system easily, as this algorithm relies on three basic elements in its structure, which are Controller–View–Model.

**Table 2.** Software Requirements

Devices	Specifications
Operating system	Windows 11 pro
Ram and system type	8.00 GB 64-bits
Processor	11th gen intel(r) core(tm) i7-1165g7 @ 2.80ghz 2.80 GHZ
Data base	SQL server management studio 21
Coding language	Visual studio , C# , MVC

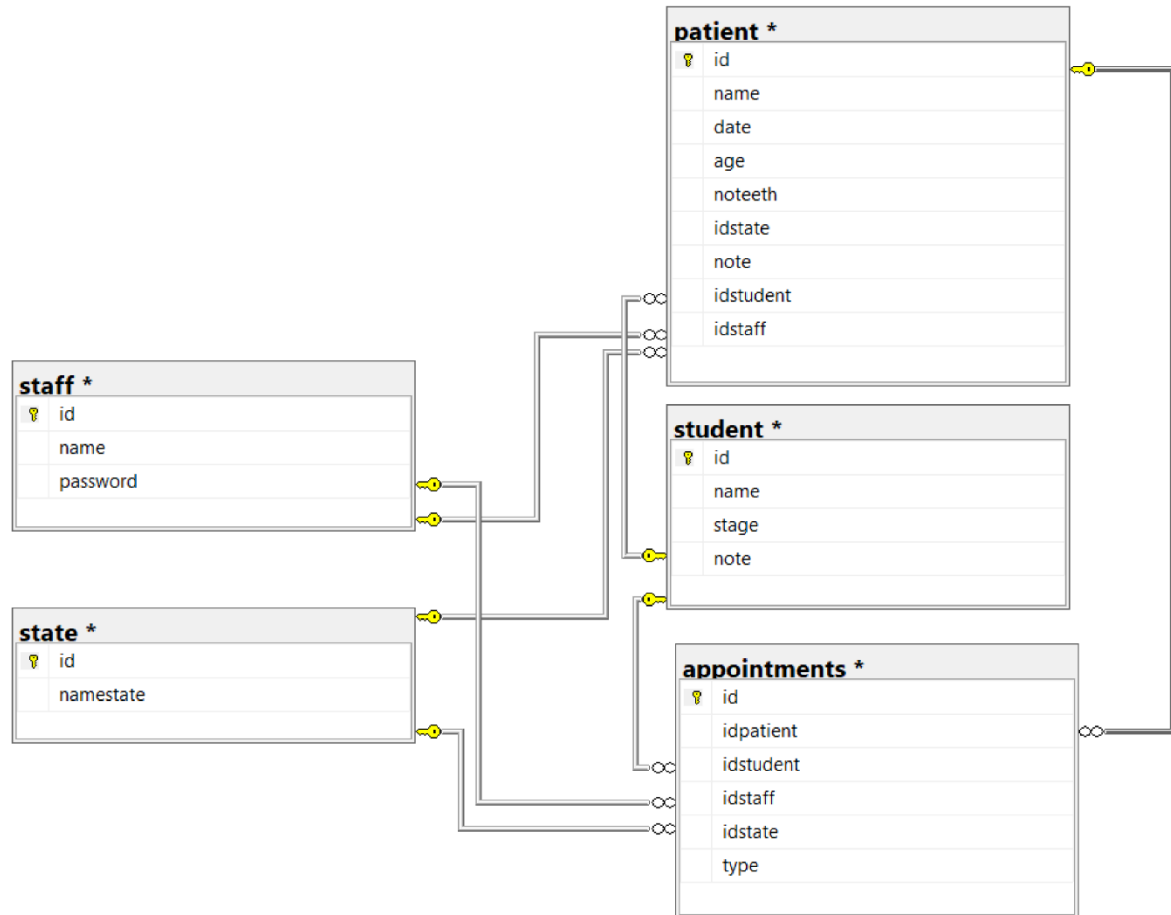
**Table 3.** Comparison between (MVC) Design and Traditional (web pages)

MVC	Traditional web pages
Focuses on data separation, and there is no code Fixed on any display page	It is attributed to the presence of the programming code within the display page Which requires writing the code on each page separately
The controller element receives the request and then by executing the request.	The page directly receives the request and then it is completed apply the code inside the page to the web server.
There is no view state for data management.	View state is a way to manage data within The page makes the page load slow.
Ease of use with scripting languages. Ease of developing the application because it allows developers to work in a parallel manner. Each part can be worked on separately without any malfunction	Complex in dealing with scripting languages. Difficulty in developing pages and slow development process

The process starts from the Controller element which is responsible for monitoring the inputs from the web user, then he/she processes the entered values, sends them to the Model element, which is responsible for performing the data update process, and then notifies the Controller element, which causes the data to be updated in The View element, which in turn reads data directly from the Model element and outputs it back to the user’s web browser when there is no data processing. In other words, if the input requires an update or change in the display data, the Controller’s turns to alert the View element that updates the display of data from the Model element and Output it to the user’s web page (Galloway et al., 2014), and (Necula, 2024) .By using the MVC pattern and comparing it with using traditional web page (Kishan Choudhary, 2017), and (Chen, 2024) . Several differences are found, and the most important ones are shown in Table [3]. On the database side, stored procedures were relied upon in designing the system’s database, as they are considered one of the most important support tools in designing databases in terms of security, reuse, and

performance, as they reduce execution time when called many times. Any procedure stored within the database specified by more than one application can be called without the need to write the same programming code (K. Wei et al., 2006), (Hartono & Erfina, 2021), and (Hussain & Khan, 2022).

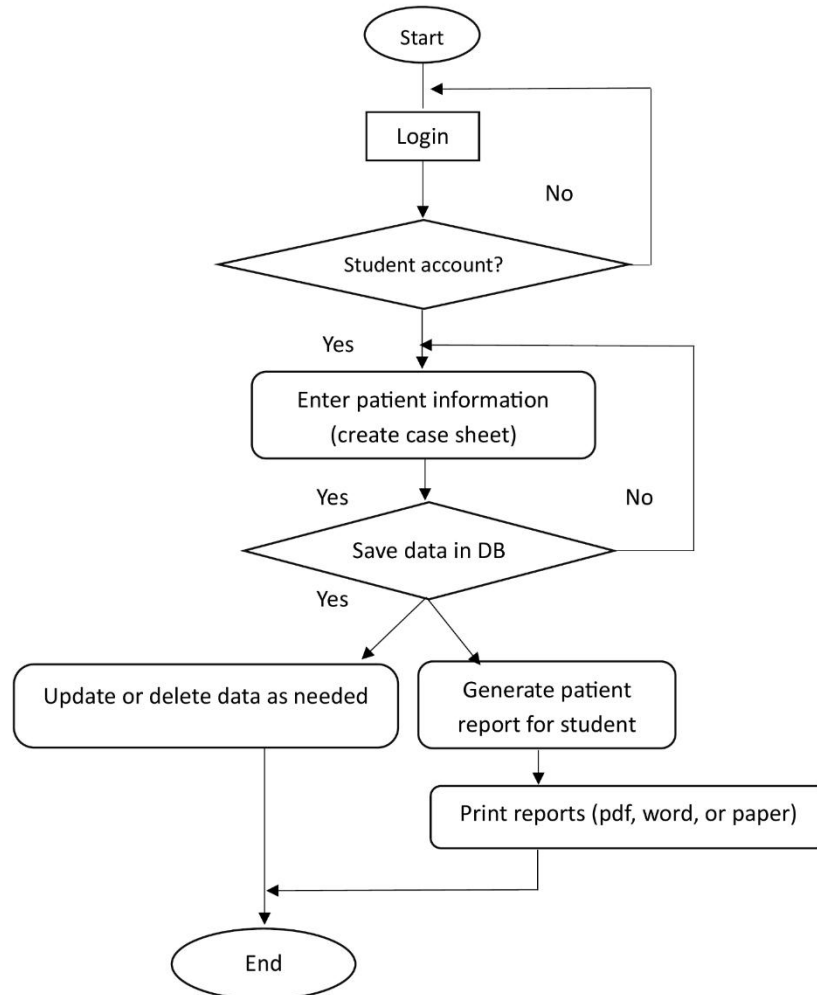
The database was designed based on the stored procedures system as explained previously. Figure 1 illustrates the relationships between the tables in the database, which consists of five main tables: “student”, “patient”, “staff”, “state”, and “appointments”.



**Figure1.** Relationships between the System’s Primary Tables

Each table contains a primary key to ensure data uniqueness and to establish relationships among the tables. The relationships between the tables were implemented according to the algorithms illustrated in Figures 2 and 3. Patient information is first stored in the “patient” table, which is linked to the “appointments” table in order to schedule and manage patient appointments. The “student” table contains the data and information of students trained in the educational clinic, including their names, academic stage, and evaluation results. The primary key “id” in the “student” table is linked to the foreign key “idstudent” in both the “patient” table and the “appointments” table. This relationship enables the system to associate patients with the students responsible for their treatment and to generate student reports used to evaluate their performance and determine whether they meet the requirements to pass the corresponding academic stage. For the medical and administrative staff working in the clinics, the “staff” table stores the basic information about the staff members responsible for supervising students and recording evaluations. The primary key “id” in the “staff” table is linked to the foreign key “idstaff” in both the “patient” table and the “appointments” table. This relationship allows the system to identify the staff members present in the clinics and responsible for managing patient appointments. Finally, the “state” table represents the clinic or the specific specialization of the cases received in each clinic according to the system followed by the college. The primary key “id” in the “state” table is linked to the foreign key “idstate” in both the “patient” table and the “appointments” table. This linkage enables the system to determine the clinic responsible for each patient and to manage the corresponding

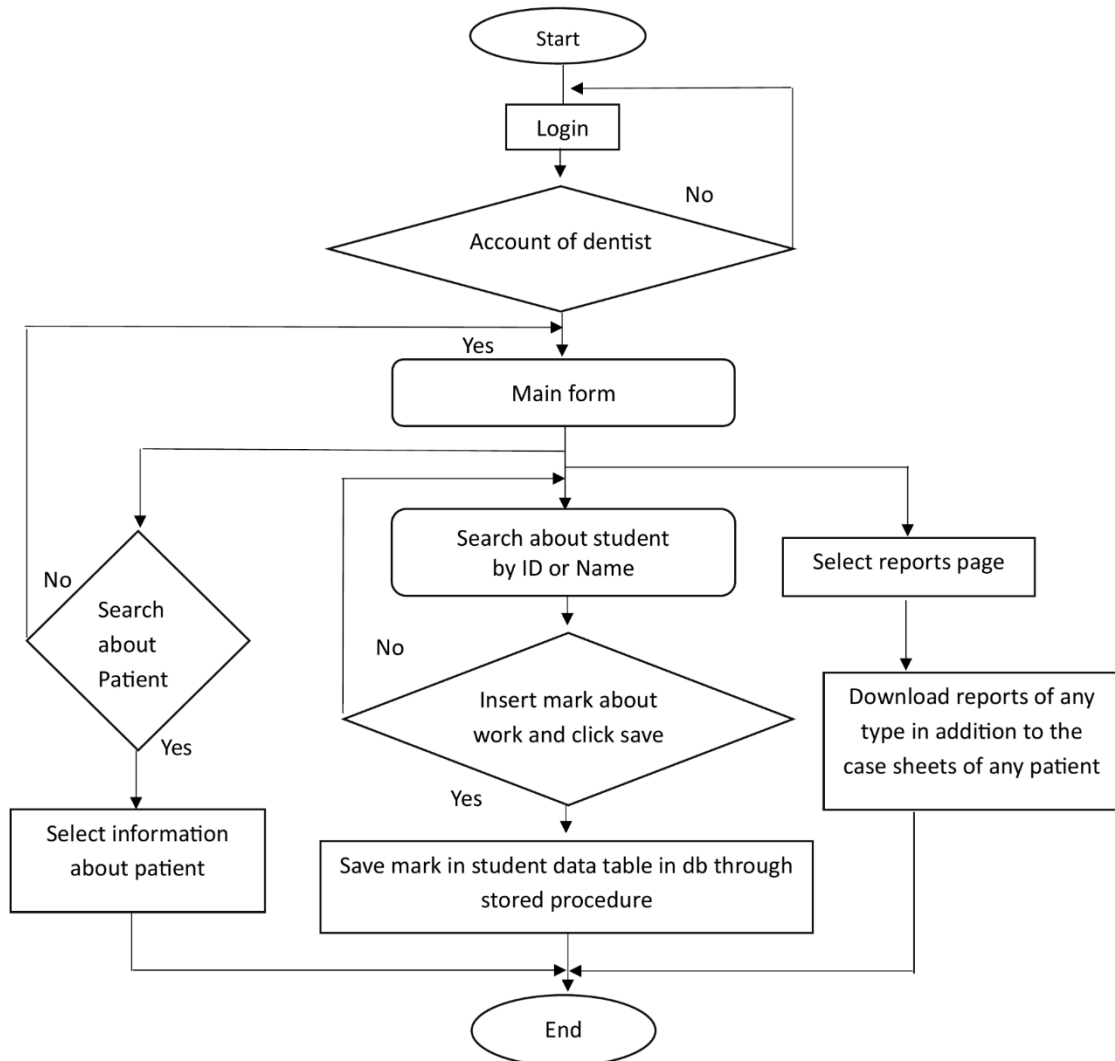
appointments accordingly. Furthermore, the primary key “id” in the “patient” table is associated with the foreign key “idpatient” in the “appointments” table. This relationship allows the system to connect each patient with their scheduled appointments and ensures proper management of patient visit records.



**Figure 2.** An Algorithm for Student Interfaces

The SQL server properties are used to program a function to back up the database every day at 12 PM. The system’s web interfaces are designed in Visual Basic C# the main algorithms of the system, as shown in Figure 2, include the part for the student trainee in the educational clinic, which represents the main goal of the proposed system. As we can see from the algorithm diagram, the student registers in the system and then enters the system from his account. The students’ special permissions will be given, which are determined by the database, which includes entering patient information into the system and configuring the patient’s case sheet, which has become electronic in the system, after relying on paper records, will then accept any modification or deletion of any information related to the patient.

The algorithm in Figure 3 shows the system’s interaction with the dentist who works in the educational clinic and supervises the students after logging in by the dentist, the system will display the home page, which contains the commands for the medical and administrative staff. Through it, the dentist will be able to navigate between the interfaces, which include searching for students through the student’s name or number. After that, the student’s evaluation can be entered, which includes the work done by the student in the clinic and according to the patient’s specific condition. After that, this data is stored in the students’ table. The patient is also searched for and his information and the prescribed treatment plan are displayed. The patient interface includes displaying the treatment plan and visit dates to the clinic. In addition, the reports that can be obtained from the system, which include information about students and patients, in addition to information about the administrative staff.



**Figure 3.** An Algorithm for Dentist Interfaces

The reports are in PDF and Excel formats and can also be printed which complies with the medical statistics requirements required by educational clinics.

As for the security part, the MVC architecture provides a kind of data protection because the user interface does not deal directly with data, and this reduces unauthorized access to the database. It gives reduced attack vulnerabilities such as SQL Injection because the view does not interact directly with the database. As for access control, the controller works as a means between the user and the database. The protection followed in the SQL server database in terms of access control has been added, the process of verifying permissions (Authentication & Authorization) before allowing access to the data. To maintain system integrity, username and password parameters should be set, make them strong, and prevent the use of symbols that lead to SQL Injection. Custom Roles access control is applied to specify precise permissions, after which users are added to this Role. To enhance data protection, Column-Level Encryption has been adopted, which is a system for encrypting only columns such as each patient’s, student’s number, and students’ grades.

### 3.3. Usability Evaluation Survey

To empirically validate the effectiveness and user experience (UX) of the developed digital management system, a structured evaluation survey was conducted. The study population comprised a purposive sample of 291 participants,

including 230 dental students, 33 clinical instructors (dentists), and 28 administrative staff members, all of whom had active interaction with the system within the educational dental clinics.

The survey instrument was structured to measure three core dimensions:

- a. Usability (4 items): Focused on system simplicity, ease of learning, and user autonomy.
- b. Professional Efficiency (3 items): Assessed the system’s impact on clinical workflow optimization and the reduction of manual administrative errors.
- c. Design and Security (3 items): Evaluated the User Interface (UI) aesthetics, system responsiveness, and the robustness of data privacy protocols.

Participants recorded their responses using a five-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (5). Data management and statistical processing were performed using IBM SPSS Statistics (version 26.0). Descriptive statistics, including frequencies, percentages, weighted means, and standard deviations (SD), were utilized to quantify user satisfaction and system performance.

## 4. Results

### 4.1. System Implementation Results

The system’s evaluations are based on users testing in educational clinics and its usefulness in achieving the primary goal, which is managing students in educational clinics. However, there are a lot of researches and programs that do not support educational clinics and are limited only to commercial clinics. By implementing the system in educational clinics in the College of Dentistry, the required security is achieved by preventing access to non-users who have access permissions. The system has also proven its effectiveness and ability in preparing the required statistics. The system also supports storing big data management because it relies on SQL Server, which in turn supports big and scalable data. Since, the technologies used also allow us to do so through stored procedures, which allow us to develop and expand in system easily. It is observed that Table No. 4 represents a comparison between the system followed in educational clinics in the College of Dentistry and the proposed system, which has proven its effectiveness and suitability for educational clinics that need centralization, high security, and efficient multiplicity of users. The system provides multiple layers of protection, while (Authentication) was used to verify the user, and (Roles) was adopted to manage access in an efficient, organized manner, and apply (Column-Level Encryption) to some fields in spreadsheets.

The diagram in Figure 4 shows the users’ opinions of the proposed system and the difference between it and the previous system that was followed in educational clinics. Through Equation No. 1, the efficiency of the system’s performance is calculated, where presents the actual time of the system and the ideal time to be achieved Equation No. 2 reveals the efficiency of the old system that was followed in educational clinics, and Equation No. 3 represents the effectiveness of the system proposed in the research, which led to an increase in competence by 96%, which is an excellent value and a qualitative shift in work.

**Table 4.** A Comparison between the Old System in Educational Clinics, Represented by Excel, and the Proposed System

No	Differentiation element	Previous program (EXCEL)	Proposed system
1	Number of records	Limited does not support large projects or big data	Manages thousands of records efficiently
2	Safety	One weak file can be copied or lost	High (Validity - Database Backups)
3	Multiple users	Limited conflicts when opening the file	Excellent supports multiple concurrent users Integrated, supports complex reports, processes, and giant systems, as well as creating detailed reports (number of students - achievement - daily attendance - and a lot of data according to the system’s needs)
4	Flexibility	Good for simple analysis only	

5	Cost	low	Higher (server - possible hosting - design - employee training)
6	Mistakes	Accepts human mistakes	It is reduced by automated verification

$$\xi = \frac{TE}{Ti} * 100\% \quad (1)$$

$$\xi = \frac{1.5}{10} * 100\% = 15\% \quad (2)$$

$$\xi = \frac{9.58}{10} * 100\% = 96\% \quad (3)$$

TE= Actual time to complete the task

Ti=The Expected time to complete the task

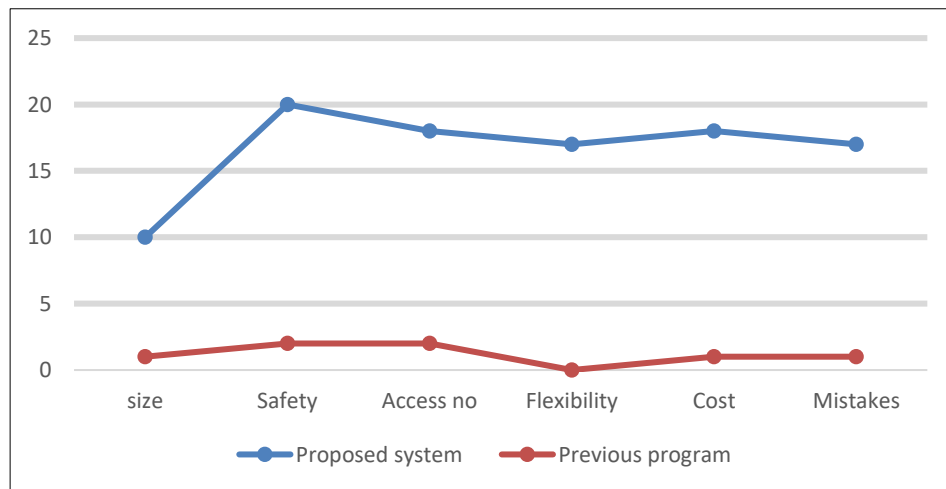


Figure 4. Performance Comparison between the Two Systems.

#### 4.2. Usability Evaluation Results

The results of the user experience (UX) evaluation provide empirical evidence regarding the system’s performance in a clinical educational setting. A total of 291 participants (230 students, 33 dentists, and 28 administrative staff) participated in the evaluation. The demographic distribution of the survey participants is illustrated in Figure 5.

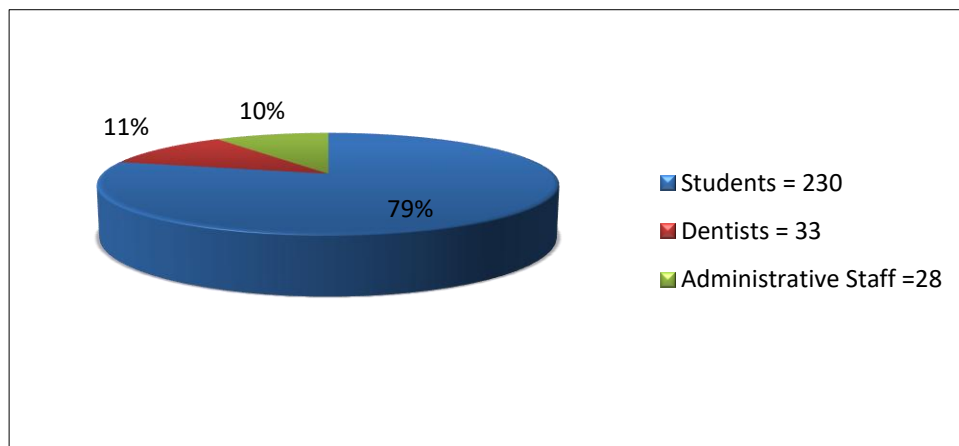


Figure 5. Participant Distribution in the UX Evaluation Survey (N = 291)

As shown in Table 5, the majority of respondents expressed positive perceptions toward the usability, efficiency, and security of the system. Most items achieved weighted mean values above 4.20, indicating a high level of user

satisfaction. The highest ranked item was related to the system’s ability to provide faster access to patient and training records (Mean = 4.36), while the lowest score still indicated a positive evaluation of system usability (Mean = 4.18).

**Table 5.** Descriptive Statistics of User Experience Evaluation for the Digital Training Management System (N = 291)

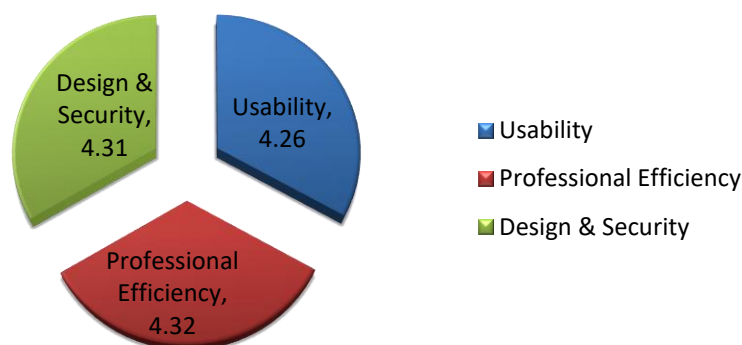
Dimension	Questions	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	Weighted Mean	Std. Deviation	Rank
Usability	System is simple and easy to use	150 (51.5)	100 (34.4)	25 (8.6)	10 (3.4)	6 (2.1)	4.30	0.91	5
	I do not need technical help each time I use the system	130 (44.7)	110 (37.8)	30 (10.3)	15 (5.2)	6 (2.1)	4.18	0.95	10
	System functions are well integrated	140 (48.1)	105 (36.1)	28 (9.6)	12 (4.1)	6 (2.1)	4.24	0.93	9
	I can learn to use the system quickly	155 (53.3)	95 (32.6)	25 (8.6)	10 (3.4)	6 (2.1)	4.33	0.92	3
Professional Efficiency	System helps access patient and training records faster	160 (55.0)	95 (32.6)	20 (6.9)	10 (3.4)	6 (2.1)	4.36	0.90	1
	System reduces administrative errors in patient data	150 (51.5)	100 (34.4)	25 (8.6)	10 (3.4)	6 (2.1)	4.30	0.91	5
	Database helps track my clinical training progress	145 (49.8)	105 (36.1)	25 (8.6)	10 (3.4)	6 (2.1)	4.29	0.91	8
Design & Security	System interface is visually clear and easy to navigate	148 (50.9)	100 (34.4)	27 (9.3)	10 (3.4)	6 (2.1)	4.28	0.92	7
	I trust the privacy and security of patient data	152 (52.2)	98 (33.7)	25 (8.6)	10 (3.4)	6 (2.1)	4.30	0.92	4
	System provides fast response when retrieving data	158 (54.3)	95 (32.6)	22 (7.6)	10 (3.4)	6 (2.1)	4.34	0.91	2

The dimension summary presented in Table 6 shows that the Professional Efficiency dimension achieved the highest overall mean score (4.32), followed closely by Design and Security (4.31) and Usability (4.26). These findings suggest that the digital management system effectively improves administrative workflow, enhances data accessibility, and provides a reliable and secure platform for managing student clinical training records.

**Table 6.** Dimension Summary of UX Evaluation

Dimension	Mean Score	Std. Deviation	Interpretation
Usability	4.26	0.93	High Satisfaction
Professional Efficiency	4.32	0.91	Very High Satisfaction
Design & Security	4.31	0.92	Very High Satisfaction

The comparison of mean scores across the UX evaluation dimensions is illustrated in Figure 6.



**Figure 6.** Mean Scores of UX Survey Dimensions

## 5. Discussions

Information technology is very important in the healthcare field, but it may face some challenges when implemented on the ground due to a lack of trust or training in the proposed systems. Perhaps the weak institutional support for digital technologies in (Lee et al., 2025) 20 articles were reviewed for the period after 2019. This review identified the major organizational problems that hinder digital transformation in the health field and recommended the need to overcome weak trust among patients by developing integrated strategies between psychological and educational behavior to improve digital transformation and advance the health reality and achieve digital transformation (Blasiak et al., 2022), and (VanDeWiele et al., 2025). In (Said, 2023), the application of digital technology in the medical field depends on several factors, including trust, language, culture, and ease of use. These factors must be taken into consideration when designing any application.

The success of digital transformation is not only linked to technology, but also depends on the infrastructure, societal culture, and technology that provide ease of use (Shagembe et al., 2025). (Aldogher & Halim, 2025), and (Hasan et al., 2024) provided a scientific guide for adopting digital health services in Saudi Arabia. The research studied the effects of cultural values and infrastructure on digital transformation and customer participation in the field of health care. The study also showed that ease of use and cultural compatibility in the field of digitization contribute to facilitating the digital transformation of health care (Alhashmi, 2025), and (Suleiman & Ming, 2025).

The survey, conducted in Germany and Switzerland, highlighted the extent to which digital technologies are being applied in private dental clinics and the factors influencing digital transformation. The results found that the age of doctors affects the use of digital technology, as well as the size of the clinic, the larger it is, the more it needs digital management due to the presence of a larger number of employees and a larger number of devices, and the other factor is specialization, as some specializations use digitization more than others (Kernen et al., 2025).

The study in (Dawa et al., 2025) indicates that doctors are optimistic about the potential of artificial intelligence in the future. However, they did not use it widely. This study clarified the various challenges among the participants, such as the issue related to medical responsibility and lack of knowledge of technology. Entropy (Information Theory) was used, and with the decrease in this value, it became clear that doctors' opinions became more in agreement with artificial intelligence. The study also found that younger doctors are more prepared for artificial intelligence.

In (Wani et al., 2026) cases, the aim of the study conducted on the 42 Australian universities was to find out the educational programs taught in the field of digital health and the implementation of digital systems, health data analysis and leadership in digital transformation. The results found that 26 study programs were related to the field of digital health and 18 programs specialized entirely in digital health, but most of these programs were for postgraduate studies and a small portion were at the undergraduate level. Thus, the study found the need to develop education in digital health in order to fill the shortage of required skills, and to train specialists capable of innovating and designing digital systems in the health field. (Franco & Minervini, 2024) includes talk about the use of dental devices that rely on artificial intelligence in diagnosis, such as the CAD/CAM program and remote diagnostic devices, thus saving effort

for patients who suffer from difficulty moving, but it does not support training programs for dental students. Research (Chuang et al., 2025) Artificial intelligence has been used to diagnose gum disease through clinical observations made by the doctor, such as diagnosis, gum condition, and treatment plans. This data that the doctor enters into the digital system is often disorganized, as the proposed system extracts valuable information from the diagnosis and converts it into organized data within digital records. Artificial intelligence algorithms for understanding texts were adopted (GPT-4, NLP techniques, and Roberta). These models were trained on 360 random observations selected from clinics. A comparison was made between the real results and the results achieved from training artificial intelligence algorithms, and the accuracy was very high, represented by 98%, and this percentage is considered outstanding for artificial intelligence models in the medical field. This study succeeded in reducing manual work, improving the quality of digital medical records, and automatically diagnose gum disease (stage of the disease, speed of disease development, and extent of disease spread in the mouth), thus improving the management of digital records with artificial intelligence. The work was concerned with patient data only. It did not support educational clinics in which training students on patients under the supervision of dentists was the main element. In (Garaicoa et al., 2023) the study talked about a fully digital workflow for treating the condition. The researchers used facial and dental scanners together because they provide accurate diagnosis and fully digital treatment delivery. Digital transformation in dentistry has helped doctors with complex prosthetic treatments such as building the entire mouth with high precision.

Despite the development in technology in the field of dentistry, many clinics still use paper records to manage their data. This leads us to several problems, including delays or failure to organize appointments correctly, difficulty accessing patient data, and the patient's inability to see the date and times of their visit to the clinic. The proposed system (Ho et al., 2024) provides the possibility of booking appointments in advance, seeing the treating physician's notes, and the possibility of communication between the doctor and the patient.

No previously mentioned options apply the management of educational clinics in dental colleges or dental student training centres. However, it is rather limited to technology in the field of diagnosing oral diseases, and the management of private clinics only, which does not provide communication between the dental student, the supervising physician, and the patient, in addition to the administrators in the clinics.

## 6. Conclusion

The proposed system represents an important step in the digital transformation in the field of dentistry. Moreover, it helps to follow up on the training of dental college students, follows up on patients, ease of data management and accuracy. Furthermore, the system has also proven that information technology can improve the quality of medical training programs. By improving the monitoring of student performance, the system provides us with clear documentation of the clinical operations that students perform on patients in dental educational clinics, evaluating their performance quickly and accurately, and also provides improved work efficiency by allowing multiple users to work on the system simultaneously through the architecture used in Design. Technically, all technologies used in the system provide ease of system maintenance and development, as well as ease of expansion and future addition according to the emerging need in dental educational clinics. In the future, artificial intelligence algorithms can be added that provide us with data analysis and prediction of a set of expectations that help evaluate work in clinics, because through the system we now have a stock of a database for educational clinics that can be worked on and benefited from. Adding artificial intelligence algorithms to diagnose medical conditions, which assists dentists and students diagnose and confirms certain conditions. Artificial intelligence algorithms can also be applied that help read and detect images, such as reading medical x-ray images or students' images to automatically record their presence in the clinic. Therefore, it will support the system effectively. Mobile applications can also be included. Finally, the Ministry of Higher Education extended their support to all dental faculties in Iraq.

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