

## Development of a medical application as an integrative activity

### Desarrollo de una aplicación médica como actividad integradora

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#### Abstract

The importance of collegiate work in educational institutes of all levels has been increasing in recent years. In the case of the Universidad Autónoma de Tlaxcala with the incorporation of integrative activities combining different learning units, accordingly the development of specific software becomes more complete, helping the Computer Engineering student to combine their knowledge in a planned manner. This paper presents a Medical Application project, specifically focused on the development of a medical appointment generator called Vida Sana, which was built as an integrative activity using the reference model CMMi Dev Level 2 model, under the waterfall methodology. The idea is that software development is done by the students in an organized manner, coordinating individual learning of seven learning units to achieve a quality application for Android mobile devices.

#### Resumen

La importancia del trabajo colegiado en las instituciones educativas de todos los niveles ha ido en aumento en los últimos años. En el caso de la Universidad Autónoma de Tlaxcala con la incorporación de actividades integradoras por semestre, conjuntando diferentes unidades de aprendizaje, en consecuencia el desarrollo de un software específico se vuelve más completo, ayudando al estudiante de Ingeniería en Computación a combinar sus conocimientos de una manera planificada. En el presente artículo se presenta un proyecto de Aplicación Médica, específicamente se enfoca en el desarrollo de un generador de citas médicas llamado Vida Sana, el cual fue construido como actividad integradora utilizando el modelo de referencia CMMi Dev Nivel 2, bajo la metodología de cascada. La idea es que el desarrollo de software se haga de manera organizada por los estudiantes, coordinando el aprendizaje individual de siete unidades de aprendizaje para lograr una aplicación de calidad para dispositivos móviles Android.

#### Integrative Activity, Medical Application, CMMi

#### Actividad Integradora, Aplicación Médica, CMMi

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**Introduction**

This project presents an integrative activity focused on the development of a medical application, carried out over three semesters, based on the CMMi Dev level 2 quality model, specifically the development of a medical appointment manager.

The Vida Sana application allows scheduling medical appointments through a calendar, making it easy to use, also working appointments for clinical analysis, blood samples and urine analysis, providing a better control between patients and specialists, as well as solving the problems that are generated when making an appointment in person, such as possible infections, long lines and waiting time.

**Working method**

In the educational programme of Computer Engineering of the Autonomous University of Tlaxcala, the integrating activity has been organised by formative fields, specifically this project is developed in the formative field of Applied Engineering. The first thing to be done is an analysis of which projects will be developed to cover the different learning units. The Software Engineering learning units have been chosen as a basis to cover the waterfall development cycle and the use of CMMi Dep level 2, and because they allow the implementation of a set of practices for software development.

The Medical Applications integrative activity was worked on over the course of three semesters, the learning units per semester are listed below:

## First stage - Fifth semester

1. Requirements Engineering and Estimation
2. Database Queries and Optimisation
3. Human Computer Interaction

## Second Stage - Sixth Semester

1. Software Design and Modelling
2. Computing for Mobile Devices
3. Development of Virtual Environments

## Third Stage - Seventh Semester

1. Software Testing and Deployment
2. CMMi and Integrating Activity

The integrating activity is considered a didactic, pedagogical, epistemic and methodological curricular implementation, which allows the higher education student to articulate theory with practice and to mediate the mobilisation of their knowledge in the integral development of their professional training, and to be able to achieve the desired graduate profile [1].

The CMMI model (Capability Maturity Model integrated) is a best practice model, published by the Software Engineering Institute in 1994 with the aim of sharing best practices in software development with the industry [2].

**Medical application**

During this integrative activity 13 teams participated, belonging to two groups of Computer Engineering, each one developing a different medical management application, which started in the fifth semester and are finishing their project in the seventh semester.

Some of the medical applications that have been worked on are:

- Vital signs assessment.
- Diabetes self-diagnosis.
- Generation of medical appointments.
- Calculating calorie intake.
- Generation of invoices for a hospital.

The medical appointment generator has been selected for this article. A medical appointment generator allows you to manage the appointments of a practice or hospital in an orderly manner.

**Related work**

Here are some related works, either using a web system or mobile devices.

*Centro Jel Riobamba Medical Appointment Manager*

Since the JEL Physical Therapy Centre did not have a medical appointment system, a mobile application for appointment management was developed, which has reduced the backlog of medical appointments. During the development stage of the mobile application, the agile methodology Mobile-D and the hybrid framework Ionic were used. The mobile application was evaluated by expert users in usability, with the aim of knowing the degree of usability that the application contains by means of a survey, the expert users consider that it is easy to use, to learn and recommended the use of the mobile application [3].

*Medical appointments at the Municipal Hospital Los Olivos*

The Web System for Medical Appointment Booking Processes at the Municipal Hospital Los Olivos was developed to avoid waiting time for patients to request a medical appointment. The Web System is developed based on the RUP (Rational Process Unified) methodology and with MySQL database that will allow to carry out the activities of the user in charge in the determined process. The present research project is of applied type, with a Preexperimental design [4].

*Control of medical appointments for the clinic of the Ecuadorian Air Force No. 11 Wing in Quito*

The Design and Implementation of Software for Medical Records Management and Medical Appointment Control for the Ecuadorian Air Force Clinic of the 11th Wing in Quito was developed by students combining research and development oriented to medicine and computer science, the software allows the management of medical records and control of medical appointments to raise the level of service at the clinic [5].

**Vida Sana application**

The Vida Sana application allows patients to schedule medical appointments through a calendar in a simple, efficient and controlled manner.

The first stage of the development of the Vida Sana application was worked on in the fifth semester, where three learning units were involved.

In the Requirements Engineering and Estimation learning unit, the documentation of the Requirements and Planning Phases was elaborated according to CMMi Dep Level 2 specifications, as these phases are indispensable for a correct definition of requirements and to ensure the fulfilment of the project plan. Figure 1 shows the functionality of the Vida Sana system as an example.

Nº	Nombre del Caso de Uso	Prioridad	Complejidad
01	CU01_Registrar usuarios	Esencial	Simple
02	CU02_Registrar especialistas	Esencial	Simple
03	CU03_Iniciar sesión	Esencial	Simple
04	CU04_Calendarizar citas	Esencial	Medio
05	CU05_Visualizar especialistas	Esencial	Simple
06	CU06_Revisar perfil	Util	Simple
07	CU07_Reagendar citas	Esencial	Medio
08	CU08_Revisar historial	Util	Medio
09	CU09_Subir resultados médicos	Esencial	Complejo
10	CU10_Revisar resultados médicos	Esencial	Complejo

Figure 1 Functionality of Vida Sana

Figure 2 shows the Vida Sana use case diagram.

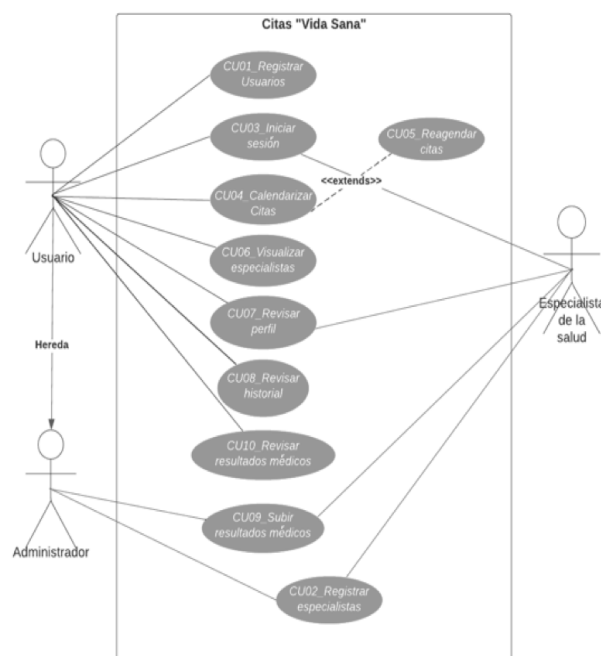


Figure 2 Vida Sana Vida use cases

In the learning unit of Queries and Database Optimisation we worked with the Entity-Relationship Model and SQL queries, Figure 3 shows the Healthy Life Entity-Relationship Model.

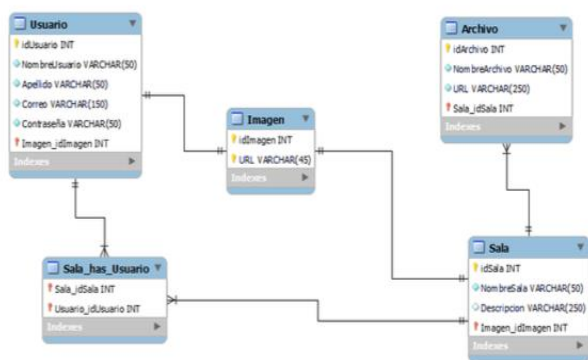


Figure 3 Entity-Relationship Model

The Human-Computer Interaction learning unit dealt with the design of Interfaces using figma, as well as considering the following usability principles.

Ease of use and understanding of the interfaces.

Shortcuts in the application.

Minimise user workload with the use of a calendar for scheduling medical appointments.

User-friendly functionalities.

Allows undoing of actions performed in case of user error. Two interfaces that were worked on in the Human Computer Interaction learning unit are shown below, see Figure 4 and Figure 5. The interfaces were developed in Figma, a prototyping tool and vector graphics editor, which is hosted on the web.

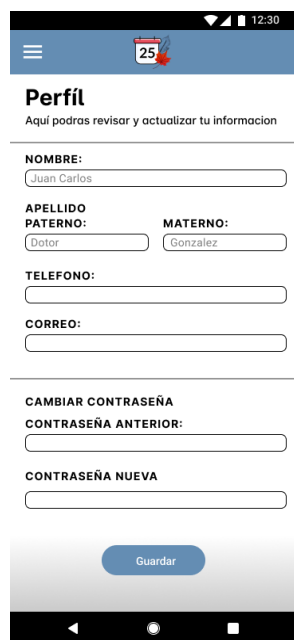


Figure 4 Vida Sana Registration Interface

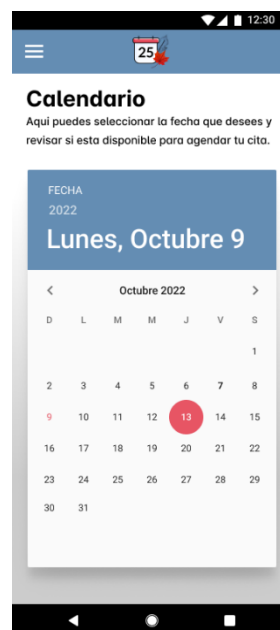


Figure 5 Calendar to schedule appointments in Vida Sana

For the second stage of development, the following three learning units were worked on.

In the learning unit Software Design and Modelling, the logical design with UML diagrams and the construction of the application were carried out. Figure 6 shows a sequence diagram, which indicates that the scheduling of appointments is an essential functionality of the application, in which the patient must select the available date from a calendar. Subsequently, he/she can choose the desired time, the type of appointment required and the corresponding medical specialist. Once this process is completed, the patient user can save the appointment and access it in the "scheduled appointments" section. This function allows an efficient and organised management of medical appointments, providing the patient with the convenience of visualising and having complete control over their scheduled appointments.

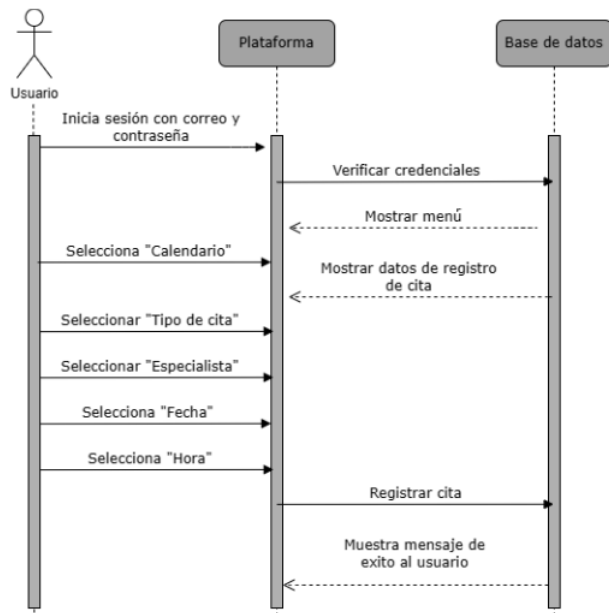


Figure 6 Sequence diagram of Vida Sana Register

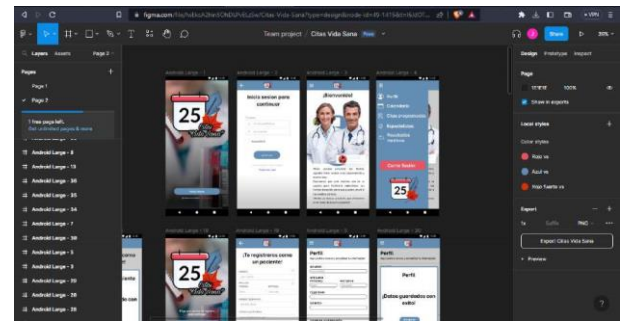


Figure 9 Implementation of the Healthy Living Application

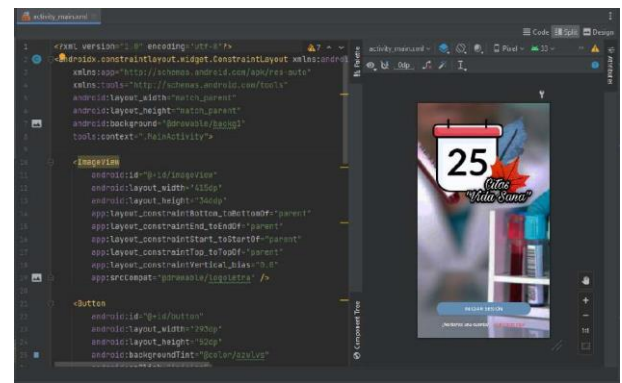


Figure 10 Vida Sana main screen

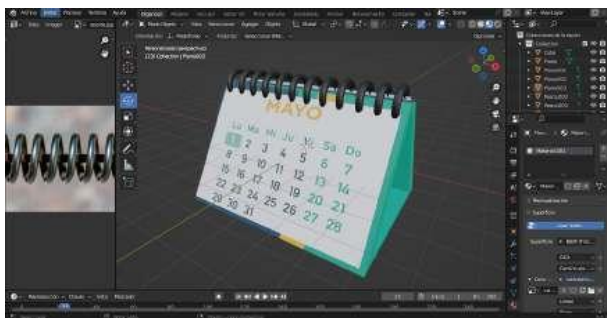


Figure 7 3D Calendar made in Blender

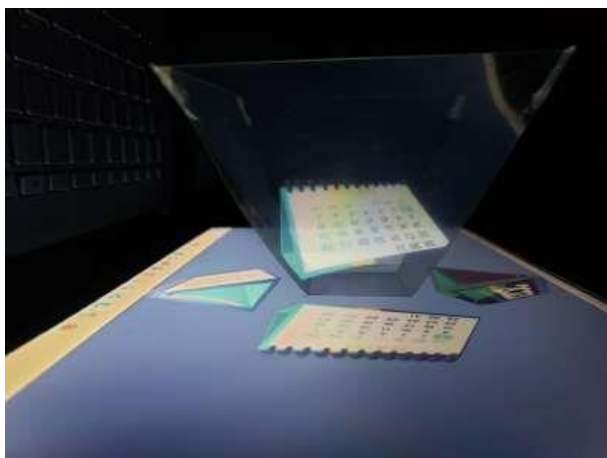


Figure 8 Pyramidal holography of the calendar

In the learning unit Design of Virtual Environments we worked with 3D modelling of objects related to the application and pyramidal holography, for the dissemination of the integrative activity, where we used the methodology of virtual worlds found in [6]. Figure 7 shows a calendar modelled in 3D using Blender, Figure 8 shows the pyramidal holography of the calendar.

In the learning unit of Computing for Mobile Devices, the application was developed using Android Studio, as it allows to make mobile applications in a friendly environment, the application was programmed in Java language. Figure 9 shows the implementation of the Vida Sana application. Figure 10 shows part of the Vida Sana code.

The third phase is currently being worked on in the Software Testing and Implementation learning unit, where different tests are carried out for each application developed, including Vida Sana, as well as the implementation of the developed software.

## Conclusion

The educational programme of Computer Engineering is a degree that works with multidisciplinary teams, since nowadays the use of software and applications is highly demanded, so it is feasible to look for projects that solve a problem in a real context where software can be used. Each software developed allows the student to apply their knowledge from the different learning units, giving a more complete context when teachers and students come together.

Including CMMi Dev Level 2 allows the software developed to be approached at all stages with a quality focus, ensuring that it can be used for what it was created for.

Finally, venturing into the area of medicine has been enriching for both students and teachers, achieving positive feedback from participants.

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