













## Web application for attendance management with QR Technology in a Public Elementary School





### Aplicación Web para la gestión de asistencia con Tecnología QR en una Escuela Primaria Pública

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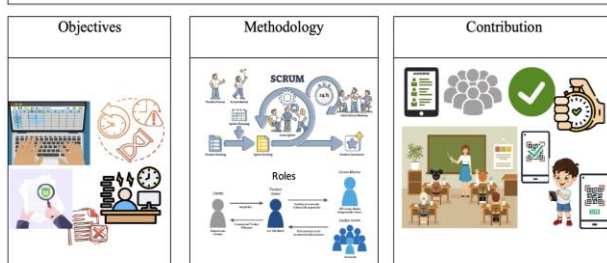
#### Abstract

Educational institutions must constantly update themselves with technological tools to improve the teaching-learning process. Student attendance is crucial, as their non-attendance affects their academic development. Currently, attendance control in the Public Primary School is carried out manually, being inefficient. Implementing technologies such as the QR Code can streamline this process by enabling faster and more accurate registration, instant access to data, early interventions for students with frequent absences, and error reduction. In addition, it facilitates integration with school management systems, promoting a more proactive and student-centered educational environment. For the development of the web application, the SCRUM methodology was used, which will allow agile and collaborative management, ensuring adaptability and continuous improvement of the system. This solution will not only optimize attendance registration, but will facilitate more accurate tracking of students' academic performance.

#### Resumen

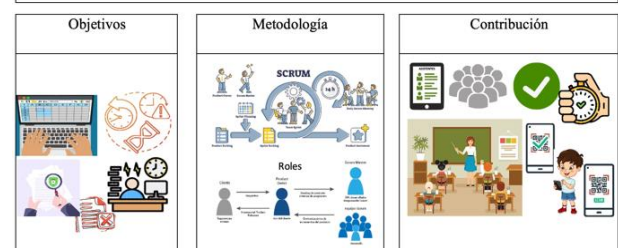
Las instituciones educativas deben actualizarse constantemente con herramientas tecnológicas para mejorar el proceso de enseñanza-aprendizaje. La asistencia de los alumnos es crucial, ya que su inasistencia afecta su desarrollo académico. Actualmente, el control de asistencia en la Escuela Primaria Pública se realiza manualmente, siendo ineficiente. La implementación de tecnologías como el Código QR puede optimizar este proceso al permitir un registro más rápido y preciso, acceso instantáneo a datos, intervenciones tempranas para alumnos con inasistencias frecuentes, y reducción de errores. Además, facilita la integración con sistemas de gestión escolar, promoviendo un ambiente educativo más proactivo y centrado en el alumno. Para el desarrollo de la aplicación web se utilizó la metodología SCRUM, que permite una gestión ágil y colaborativa, asegurando la adaptabilidad y la mejora continua del sistema. Esta solución no solo optimizará el registro de asistencia, sino que facilitará un seguimiento más preciso del rendimiento académico de los alumnos.

Web Application for Attendance Management with QR Technology in a Public Elementary School



SCRUM, Attendance, QR code

Aplicación Web para la gestión de asistencia con Tecnología QR en una Escuela Primaria Pública



SCRUM, Asistencia, Código QR

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**Introduction**

The control of school attendance is essential in the educational field, as it directly influences the academic performance of students. Regular attendance at a public primary school is a key indicator of parent's and student's commitment to their education, making a significant impact on their long-term academic success.

The importance of efficient attendance management lies not only in data management, but also in creating an educational environment that fosters accountability among students. Regular attendance can be a determining factor in the development of study habits and in the comprehensive education of students. Therefore, it is essential to have technological tools that facilitate the management of this important aspect of education.

The project presents the development of a Web Application for Attendance Management with QR Technology in a Public Elementary School in the city of Oaxaca de Juárez, Oaxaca. Web applications require a development methodology, which can be traditional or agile. The agile methodology used is SCRUM.

Modules for information management were defined:

- Student Management and Control Module
- QR Code Reading Module for attendance registration.
- Assistance Module
- Student Attendance Reports Module
- QR Code Consultation Module
- Access Module for User Management
- Calendar module for the Institute's event management.

This work has the following sections: Problem statement, where the current problems that Primary School is going through are cited. Development methodology, the development of a web application requires a methodology (traditional or agile) where the stages of the application are followed to reach the desired application. Results, these are important once the development methodology has been applied. Conclusions, synthesizing the most relevant points of the research.

**Problem statement**

In Primary School, attendance control is currently carried out manually, using Excel spreadsheets. Although this method can be functional, it has several limitations, such as the possibility of errors in data capture, the lack of information security and the excessive consumption of time by the administrative staff who capture the information.

There are also student leave, which can be given for two reasons, first because the parent requests it to the school authorities and second because of the number of absences that the student has. If there are thirty absences, the teacher notifies the school director through lists of the group, she communicates with the parents to justify the absences if necessary or to leave the student.

This process is done manually using an Excel file that lacks adequate security levels. Currently, this file is used by the administrator, which poses a significant risk: In case of damage to the computer equipment or the file, crucial information about students could be lost. This lack of protection and support could compromise data integrity and continuity of academic management

Recording and verifying attendance consumes valuable time that could be used in more productive educational activities. This can lead to a decrease in the quality of teaching and an increase in the workload for teachers.

Faced with this situation, the need arises to develop a web application that not only facilitates attendance registration, but also allows teachers and administrators to more effectively track absences and their justifications.

As an important fact, the school has two to three groups from first to sixth grade, with a total of three hundred nine students.

**Development Methodology**

Software development methodologies are mainly divided into two categories: the traditional methodology and the agile methodology.

The traditional methodology, commonly known as the waterfall model, is characterized by a sequential and structured approach. In this model, each phase of development must be completed before moving on to the next, which can result in rigorous but often inflexible planning. According to Royce (1970), "the waterfall model is an approach that allows developers to follow a logical and orderly process, although it can be ineffective in the face of unexpected changes" (Royce, W. W. "Managing the Development of Large Software Systems").

On the other hand, agile methodology focuses on flexibility and adaptability. Promotes continuous collaboration between work teams and customers, allowing for quick adjustments in response to changes in requirements or project environment. They intend to promptly deliver operating software to customers, who will then propose new and varied requirements to include in subsequent iterations of the system (Sommerville, 2011).

According to the Agile Manifesto (2001), "the highest priority is to satisfy the customer through early and continuous delivery of valuable software", emphasizing the importance of collaboration and responding to change (Beck et al., "Manifesto for Agile Software Development").

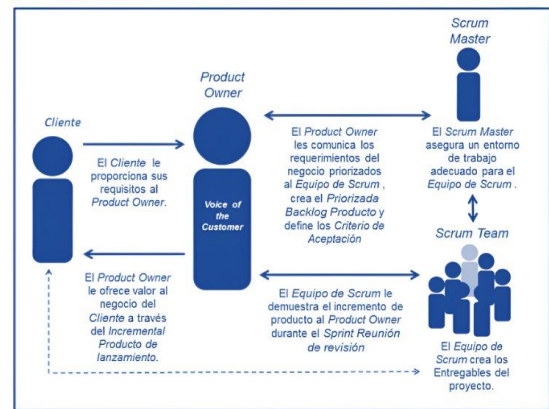
For the development of the application, the agile Scrum methodology was chosen, which allows a flexible and adaptive approach in the development process.

This methodology is based on the realization of sprints, which are short cycles of work focused on the delivery of functional increases of the product.

Scrum is a project management process that simplifies and facilitates product development, promotes teamwork and communication among the members that make up the staff, is essential to obtain more efficient results (Torrado, 2019).

Scrum has roles and these are divided into two: Roles committed to the project: Product Owner, Scrum Team and Scrum Master, other roles involved with the project.

**Box 1**



**Figure 1**

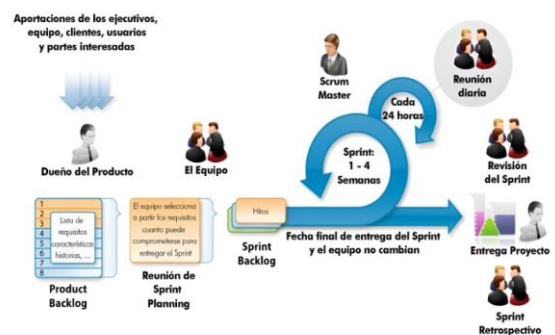
Roles in Scrum

Source: Torrado, 2019

Each sprint is made up of five ceremonies or events:

- Sprint Planning or Initial planning
- Daily Meeting or daily quick meetings
- Sprint Review
- Sprint Retrospective
- Refinement of the Product Backlog

**Box 2**



**Figure 2**

Ceremonies Scrum

Source: Schwaber & Sutherland, 2023

The Scrum methodology has Increments. The Increment is the sum of all Product List items completed during a Sprint and the value of the increments from all previous Sprints. At the end of a Sprint, the new Increment must be "Finished", which means that it is in usable condition and meets the Scrum Team's definition of "Finished". The increment must be usable regardless of whether the Product owner chooses to release it or not. (Schwaber and Sutherland, 2013)

## PHP

It is a server-side interpreted language that emerges within the current called open source (open source). It is characterized by its power, versatility, robustness and modularity. As with similar technologies, programs are integrated directly into the code HTML (Beati, 2000).

Compared to ASP, the main advantage of PHP is its cross-platform nature. On the other hand, programs in ASP are slower and heavier, and also less stable (Cobo, 2005).

### Box 3



**Figure 3**

PHP Logo

Source: [php.net](http://php.net)

## Bootstrap

Bootstrap has been characterized as an excellent tool to create clean user interfaces and fully adaptable to any type of device and screen, regardless of size. According to Acens (2016), "Bootstrap it allows developers to design responsive web applications quickly and efficiently, making it easier to create a consistent design across different platforms"

This flexibility and ease of use make it a popular choice among web developers.

Some of its features of Bootstrap are:

- Personalization: Bootstrap is highly customizable. According to Bootstrap (2023), "developers can modify Sass variables to adjust design and components to their specific needs".
- Browser Compatibility: Bootstrap ensures that websites work in all modern browsers. According to MDN Web Docs (2023), "Bootstrap is compatible with all modern browsers, ensuring a consistent user experience".
- Exhaustive documentation: Bootstrap has clear and detailed documentation.

According to Bootstrap (2023), "Bootstrap's documentation includes examples and guides that make it easy to implement for developers of all skill levels".

### Box 4



**Figure 4**

Bootstrap Logo

Source: <https://getbootstrap.com/>

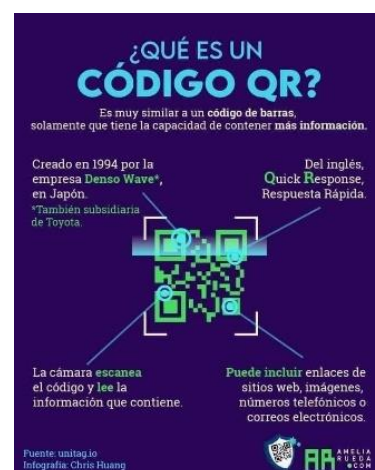
## My SQL

MySQL is a relational database management system (RDBMS). It is a program capable of storing a huge amount of data of great variety and distributing it to meet the needs of any type of organization, from small commercial establishments to large companies and administrative bodies. MySQL competes with well-known proprietary RDBMS systems, such as Oracle, SQL Server y DB2 (Beati, 2000).

## QR code

A QR code (Quick Response) is a type of two-dimensional barcode that allows information to be stored quickly and easily.

### Box 5



**Figure 5**

QR code

Source: [unitag.io](http://unitag.io)

## Characteristic:

## a. Storage capacity

It can store up to 7,089 numeric characters or 4,296 alphanumeric characters. This makes it more efficient than traditional barcodes, which are often limited in capacity (ISO/IEC 18004:2015).

## b. Quick Scan

QR codes can be quickly read by scanners and smartphone cameras, allowing immediate access to information. Their design allows them to be scanned from different angles (Denso Wave, 1994).

## c. Versatility

They are used in a variety of applications, including marketing, mobile payments, access to product information, and more. This has led to its adoption in multiple sectors, from commerce to education (Zhang et al., 2020).

## d. Damage resistance

QR codes can be read even if they are partially damaged, they can still be functional even if they have scratches or stains (ISO/IEC 18004:2015).

## e. Ease of creation

Creating a QR code is straightforward and accessible, with numerous online tools available that allow users to generate custom QR codes for different purposes (Cheng et al., 2019).

## Results

In the development of the Web application for the management of assistance with QR Technology in a Public Primary School work with the agile development methodology called SCRUM, this methodology has stages:

1. Plan
2. Build
3. Test
4. Review

These stages are repetitive until the next incremental launch is achieved, ending with multiple launches called sprints. For this project 8 sprints were necessary:

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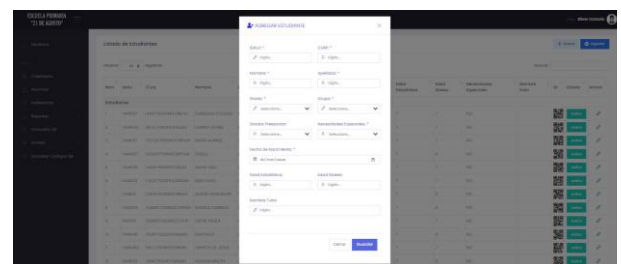
- Sprint 1: Database Creation
- Sprint 2: Module for student registration with QR code generation
- Sprint 3: QR Code Reading Module for Attendance Registration
- Sprint 4: Module for the registration of student attendance and justification of absences
- Sprint 5: Student Attendance Reporting Module
- Sprint 6: Module to consult QR codes of students
- Sprint 7: User logon and logout module
- Sprint 8: Permissions module for each type of user
- Sprint 9: Dashboard showing the students with the highest number of absences
- Sprint 10: Module to add events of important dates of the institute

In each sprint, the planning is defined: Number of the sprint, duration, objective and activities to be carried out; the meeting plan and the development of the sprint: User stories, use cases, process diagram, interface design, coding and implementation tests.

## Registration of students

To enter a new student, you must click on the “New” button, then a form is shown in which the student data must be entered, the fields marked with an asterisk (\*) are mandatory, Figure 6.

### Box 6



**Figure 6**

Registration of students

Source: Own elaboration

## List of students

There are three options to generate the list of students

1° Print the general list of students with all the corresponding data in PDF format.

2° Save the general list of students in Excel format.

3<sup>a</sup> Students' credentials are obtained, either by grade and group or solely by their student's IDALU, Figure 7.

### Box 7



**Figure 7**

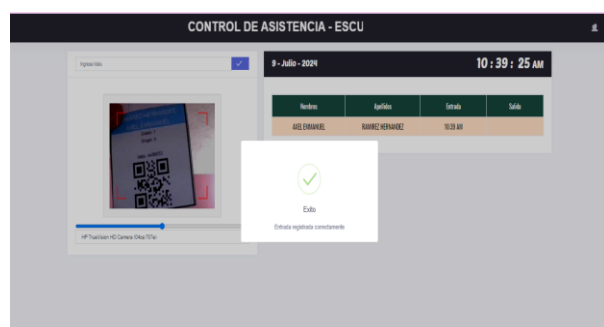
List of students

*Source: Own elaboration*

### QR Code Reading

To record student attendance, the corresponding QR code must be scanned. Once this is done, the student's data will be displayed along with the time of entry and exit as shown in Figure 8.

### Box 8



**Figure 8**

QR Code Reading

*Source: Own elaboration*

In case of scanning an incorrect or non-existent QR Code, the system will display a warning message. This will also apply if the IDALU is incorrect or non-existent.

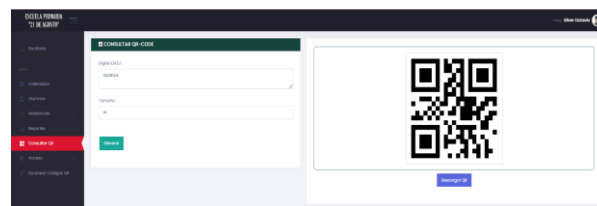
### Check QR

In this section, it is possible to obtain the QR Code of a specific student. To do this, the student's IDALU must be entered and the desired size of the QR code image to be generated must be selected.

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Then, click on the "Generate" button and the student's QR code will be displayed. You have the option to download and save the image to your computer. Figure 9.

### Box 9



**Figure 9**

Check QR

*Source: Own elaboration*

### Reports

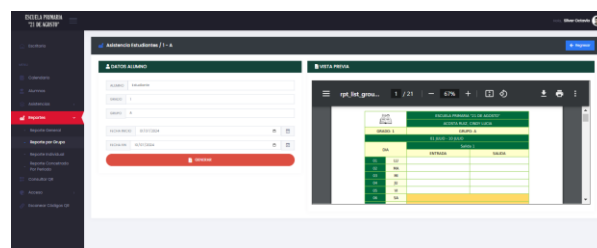
There are four types of reports:

- The first: General Report
- The second: Group report
- The third: Individual report
- The fourth: Concentrated Report by period

In the group report, you must select the group from which you want to obtain the report. The report displays student attendance information in the form of an individual list of the selected group. The report will mark the days of the week on which the student attended, missed or had a justification. If a student register two entrances and exits on the same day.

Once the group has been selected, you must enter the range of days you want to generate the report (maximum 30 days). After generating the report, it will be shown in PDF format, Figure 10.

### Box 10



**Figure 10**

Report by Group

*Source: Own elaboration*

## Conclusions

The implementation of a web application for attendance management and control in a Public Primary School has allowed to optimize administrative processes, improve information security and provide real-time data on student attendance. This project not only benefits the institution, but also contributes to the development of a more effective and organized educational environment.

QR technology has proven to be a viable and practical solution to the challenges facing attendance management, and its implementation can be replicated in other educational institutions looking to improve their administrative processes.

As technology advances, it is critical for educational institutions to adapt to these innovations to ensure quality education and efficient information management.

For future implementations, it is recommended to train teaching and administrative staff on the use of the new application, thus ensuring a smooth and effective transition. In addition, it is crucial to establish a maintenance and update protocol for the system to ensure its optimal operation over time. Constant feedback from users is also essential for making continuous improvements to the app.

## Declarations

### Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

### Author contribution

*Aguilar-Ortíz, Gabriela:* Comprehensive support in the development of the project, evaluation and optimization of the development methodology used.

*Ramos-Lira, Estefania:* Comprehensive analysis of requirements to understand the needs of the Primary School, development of the system with a focus on quality and functionality, implementation of the system, ensuring a smooth transition, and detailed evaluation to measure its performance and effectiveness.

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*Pérez-Cruz, Silver Octavio:* Comprehensive analysis of requirements to understand the needs of the Primary School, development of the system with a focus on quality and functionality, implementation of the system, ensuring a smooth transition, and detailed evaluation to measure its performance and effectiveness.

*Díaz-Sarmiento, Bibiana:* Initial evaluation of the project, methodology to be used; meetings with the team; Comparative analysis of methodologies, proposals for improvement and documentation of results.

### Availability of data and materials

The data handled in the research Web Application for attendance management with QR Technology in a Public Elementary School, are available for consultation

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To the students of Professional Residency of the Computer Systems Engineering career.

### Abbreviations

IDALU – Unique student enrollment number  
QR – It is a module for storing information in a data matrix or in a two-dimensional barcode.

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