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ANALYSIS OF STUDENT FAILURE AND DROPOUT RATES USING A WEB APPLICATION

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Abstract: This paper documents the development of a web-based educational monitoring system focused on the follow-up of failure and dropout rates. The project arises from the need for a technological tool that allows educational institutions to efficiently manage academic information and make informed decisions to improve student performance. To achieve this goal, a detailed analysis of the system requirements was carried out, considering the specific needs of the users and the best practices in software development. The project was developed using modern technologies such as Angular for the frontend and Node.js, Express and MongoDB for the backend. These tools were selected for their ability to handle large volumes of data and provide a smooth and efficient user experience. On this occasion, a comprehensive view of the development process of the educational monitoring web system is presented, from the conception of the idea to the final implementation and testing . It is hoped that readers will be able to understand and evaluate the results obtained, as well as replicate what is shown here in new projects.
Keywords: Educational monitoring, school failure rates, school dropout, web application.

INTRODUCTION

Student failure and dropout are two of the main problems affecting educational institutions worldwide. Failure (Definición de, 2024) , which implies the failure of students in their evaluations, and dropout, which refers to the abandonment of studies before completing an educational cycle (EduLat, s.f.), are complex phenomena that depend on multiple factors: academic, social, economic and personal.

The lack of timely information regarding this issue has become a major challenge that is increased by the lack of an integrated system that centralizes and automates the process of collecting and analyzing academic data since, in current practice, teachers rely heavily on spreadsheets and other manual methods to manage this critical information.

Reliance on manual methods prevents a holistic and up-to-date view of student progress, making it difficult for faculty and administrators to obtain a clear and accurate picture of academic performance and trends in failure and dropout. This not only reduces overall efficiency in academic management, but also limits the ability of institutions to implement proactive strategies that could improve student success and reduce dropout rates.

Inefficient management of grades and tracking of student performance is critical because it can negatively affect the quality of education, educational decision making and the ability to intervene early in cases of at-risk students. A centralized system is essential to improve these processes, making information more accessible and reliable.

As technologies advance, educational institutions have begun to adopt digital tools, such as web applications, to address these problems more effectively. The use of web applications has become widespread and that allow the collection, analysis and visualization of data in real time, which facilitates the identification of patterns, trends and factors associated with student failure and dropout. Through these systems, students can be tracked, their performance can be predicted and personalized interventions can be designed.

In order to address these challenges, the project "Educational Monitoring System focused on Failure and Dropout Rates" was developed. This system is designed to provide accurate and timely information on failure and dropout rates, enabling educational institutions to make informed decisions and take effective corrective measures. Failure, if not properly managed, can lead to academic lag and negatively affect the terminal efficiency of Higher Education Institutions (HEIs) (UDAVINCI, 2024) , which is a crucial goal for these entities.

The project involves the implementation of a web application and a database that facilitates teachers' access to student lists and the control of failure and dropout rates. In addition, the system allows the generation of graphical statistics that reflect the status of the curriculum per semester. These functionalities are designed to improve the visualization and analysis of academic data, thus addressing the needs regularly reported by teachers and contributing to the accreditation evaluation related to lag and terminal efficiency.

The project focused on the development of an interface that allows teachers to access and centrally manage grades, as well as monitor key performance indicators such as failure and dropout rates. This system was designed specifically for the context of the Instituto Tecnológico de Cuautla, considering its needs and academic structure.

The methodology used for the development of the system is Scrum, an agile methodology that promotes flexibility, collaboration and incremental delivery of functionalities. Scrum facilitates adaptation to changes and allows efficient project management through iterative sprints and periodic reviews, responding in a timely manner to the needs of the institution and users.

Modern technologies such as Angular for the frontend and Node.js, Express and MongoDB for the backend were used in the development of the system. These tools were selected for their ability to handle large volumes of data and provide a smooth and efficient user experience (D Gibert, 2020) . The implementation of this advanced technology seeks to improve academic management, optimize the use of time and resources, and provide a centralized platform for the organization and analysis of information.

MATERIALS AND METHODS

For this research project and design of the information system, the Scrum methodology has been selected, taking advantage of the best of this methodology in the management and organization of the project. The type of research that was carried out is applied research, since it seeks to address a practical and specific problem related to the implementation of an information system in the institution (Ángeles, Acosta, Zavaleta, & Domínguez, 2022) .

The Scrum methodology is an agile framework used for project management, especially in software development. It is based on collaboration, self-organization and flexibility to meet project objectives efficiently (Sordo, 2023). Its main components are:

1. Roles:
   - Product Owner: Responsible for maximizing product value and managing the product backlog.
   - Scrum Master: Facilitates the Scrum process and helps the team to follow agile practices.
   - Development Team: Self-organized group working on product delivery.
2. Events:
   - Sprint: Fixed-time duty cycle
   - Sprint Planning: Meeting to plan the work of the next sprint.
   - Daily Scrum: Daily 15-minute meeting to synchronize activities and plan the day.
   - Sprint Review: Review of work completed at the end of the sprint.
   - Sprint Retrospective: Reflection on the sprint to improve the next cycle.
3. Artifacts:
   - Product Backlog: Prioritized list of all work that might be needed on the product.

- Sprint Backlog: List of selected tasks for the current sprint.
- Increment: Sum of all backlog items completed during a sprint and all previous sprints.

Scrum is ideal for projects that require adaptability and speed, allowing teams to respond to changes and deliver value continuously . Moreover, the SCRUM methodology presents the following key considerations (Martins, 2024) :

1. Requirements Analysis
- Needs Identification: Understand the needs of users (administrators, teachers, students) and key indicators to monitor.
- Defining Objectives: Establish clear objectives, such as reducing dropout rates and improving pass rates.

2. System Design
- System Architecture: Decide on the structure of the system, including the database, server and user interface.
- User Interface (UI): Design an intuitive and accessible interface for all users.
- Security: Implement security measures to protect sensitive student data.

3. System Development
- Programming: Use appropriate programming languages and frameworks (e.g. Python, Django, JavaScript, React).
- Data Integration: Connect the system with existing databases and ensure proper data migration.
- Testing: Perform extensive testing to ensure that the system is working properly and is free of errors.

4. Implementation
- Deployment: Install the system on the servers and ensure its availability to users.
- Training: Provide training to users on how to use the system effectively.

5. Monitoring and Evaluation
- Continuous Monitoring: Monitor the use of the system and collect feedback for continuous improvement.
- Impact Evaluation: To measure the impact of the system on the reduction of school failure and dropout rates.

6. Continuous Improvement
- Upgrades: Perform periodic upgrades to improve system functionality and security.
- Adaptation to New Needs: Adjusting the system according to new needs and changes in the educational environment.
- Implementing an educational monitoring system can be a complex process, but with proper planning and a user-centered approach, it can have a significant impact on improving education.

Based on the fundamental aspects of the SCRUM methodology, we proceeded to the Installation and configuration of the development environment by downloading and installing nodejs in its version 20.9 in its version 10.1 to continue with the installation of angular 17 in its latest version. Once nodejs, npm and angular were installed, we proceeded to the creation of the projects. For the backend a project was created with the 'npm init' command called 'api_server' with nodejs and libraries were added for encryption, security and extra functionalities such as token creation and mailing. Visual Studio Code was used as IDE (Integrated Development Environment). An essential tool in the development of this project was Postman, which facilitates working with HTTP requests, to test the backend server.

The backend of the educational monitoring system developed in nodejs was structured with the following folders as shown in Figure No. 1:

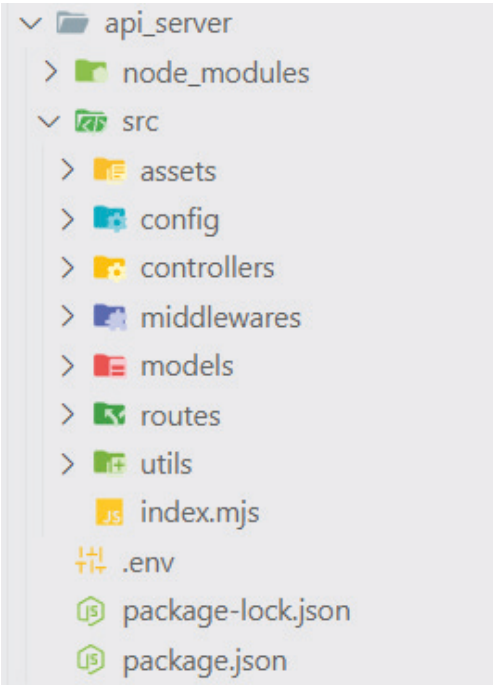


Figure 1. Backend folder structure . Own elaboration

The backend server was configured to accept the JSON format, specify the port, and define the valid addresses to accept HTTP requests. In addition, CORS parameters were configured to allow access control, as well as available HTTP headers and methods. Since the backend server works as an API, the next step was to establish a route for each request. The backend server has a functionality that allows uploading csv files to import the list of students in a group.

Through controllers it is possible to assign the new grades captured by the teacher to the students, as well as to calculate/update the averages. The system generates PDF files exporting the grades per unit or subject, as well as the final grades. All student management controllers are designed to be used exclusively by teachers.

The structure of the frontend of the educational monitoring system developed in Angular is shown in Figure No. 2:

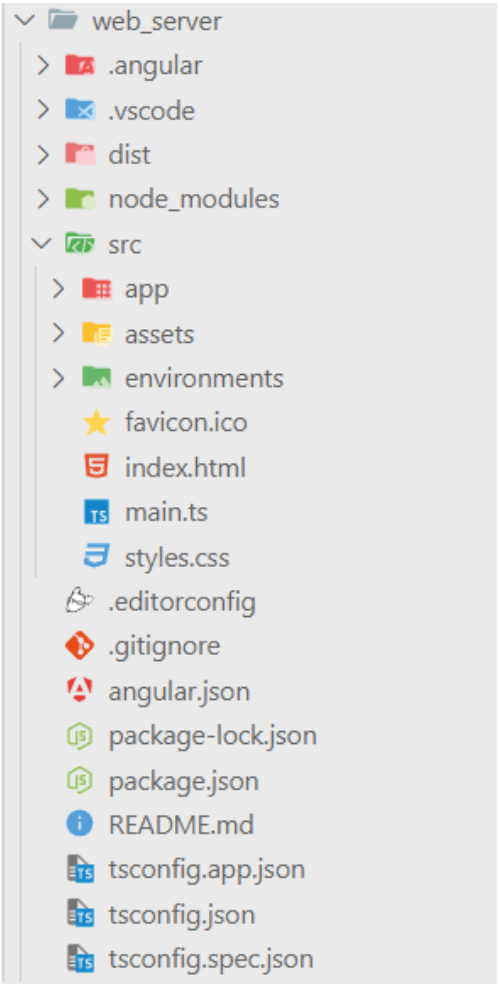


Figure 2. Frontend folder structure . Own elaboration.

The page to capture grades was designed to emulate the functionality of a spreadsheet, facilitating the interaction with the data. This page displays student names, activities and units, each with their respective input fields for recording grades. Several indexes are used to capture the grades, referring to the student's roster number, as well as the corresponding unit and activity. This indexing system allows the capture of all new grades.

RESULTS

The results obtained after the implementation of the system are presented below, including the analysis of the tests performed starting with the dialog to upload the list of students in a group in csv format (Figure 3).

The following screen (Figure No. 4) shows the group information, the list of students, as well as their grades.

The page to capture the grades of the students in the group is shown in Figure No. 5.

Once the grades have been entered, it is possible to download the PDF containing the grades of the selected unit or the final grades of the group through the following dialog shown in figure No. 6.

The PDF generated by the system has the official logos, as well as the students' grades in each unit or subject (Figure No. 7).

As mentioned above, the system generates statistics and graphs based on student achievement, as shown in Figure 8.

Additionally, key functionalities were integrated, such as printing and downloading reports in PDF format, which improves efficiency in the consultation and updating of student grades. Therefore, it can be said that these technologies not only ensure greater efficiency in document management, but also improve academic planning and evaluation within the campus.

DISCUSSION

Web systems for educational monitoring are essential tools for managing and improving the quality of education. These systems allow the collection, analysis and visualization of educational data in real time, facilitating informed decision making and the implementation of effective policies. An example of this is the Sistema para Monitoreo Educativo (MONITO) (Mexicanos Primero, 2021), , a platform that facilitates the monitoring of statistics, indicators and policies at national and state level. It offers information organized by state, including educational statistics and indicators, objectives, strategies and actions of sectoral programs. This platform allows citizens, parents and the educational community to access crucial information on the performance of the state education system. Its main benefit is that it fosters transparency and accountability, while facilitating evidence-based decision making .

CONCLUSIONS

The implementation of the web-based educational monitoring system at the Instituto Tecnológico de Cuautla stands out as a crucial tool to address complex problems such as failure and dropout. Through this system, the initial hypothesis that a digital platform with a robust database can provide strategic information to optimize academic management and improve educational indices is validated. This study highlights the need to further explore how similar systems can be adapted to other educational institutions. In addition, it would be valuable to investigate the long-term impact of these systems on academic performance and dropout reduction.

The web-based system developed for the Instituto Tecnológico de Cuautla represents a significant advance in educational management, allowing for early intervention and data-driven improvement strategies. The results underscore the importance of incorporating innovative technologies in education, not only to monitor, but also to transform teaching and learning processes. This marks a step towards a more inclusive, efficient and adaptive education. This project has enabled the implementation of a user-friendly interface that allows teachers and administrators to interact quickly, intuitively and in real time with the system. This ensures efficient navigation and optimizes loading, eliminating the problems of manual processes that previously generated disorganization and loss of information.

In summary, digitization in document management not only facilitates access to information, but also contributes to a more organized and efficient academic management.

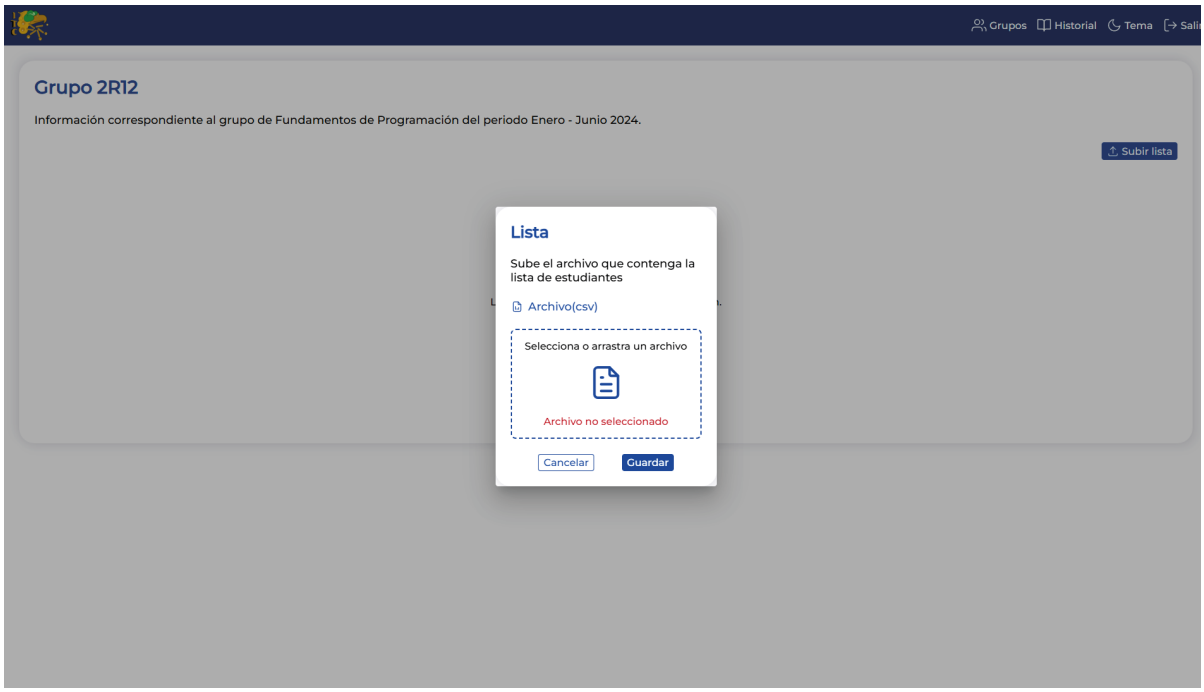
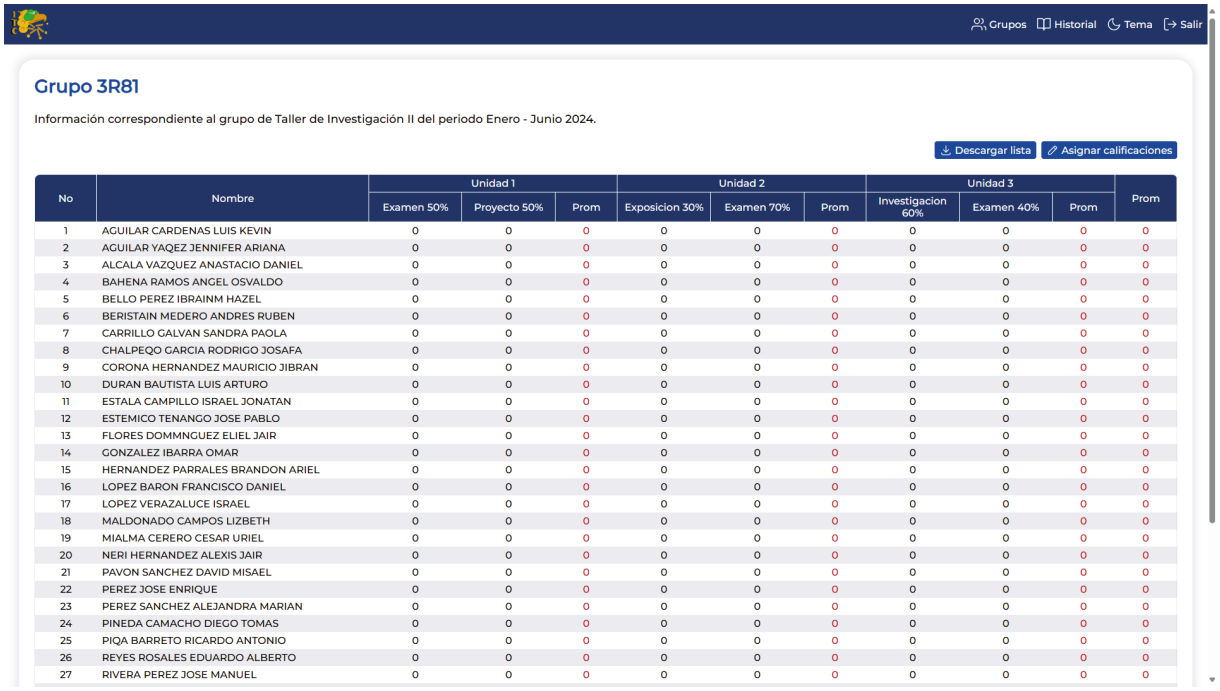


Figure 3. Dialog to upload list of students. Own elaboration

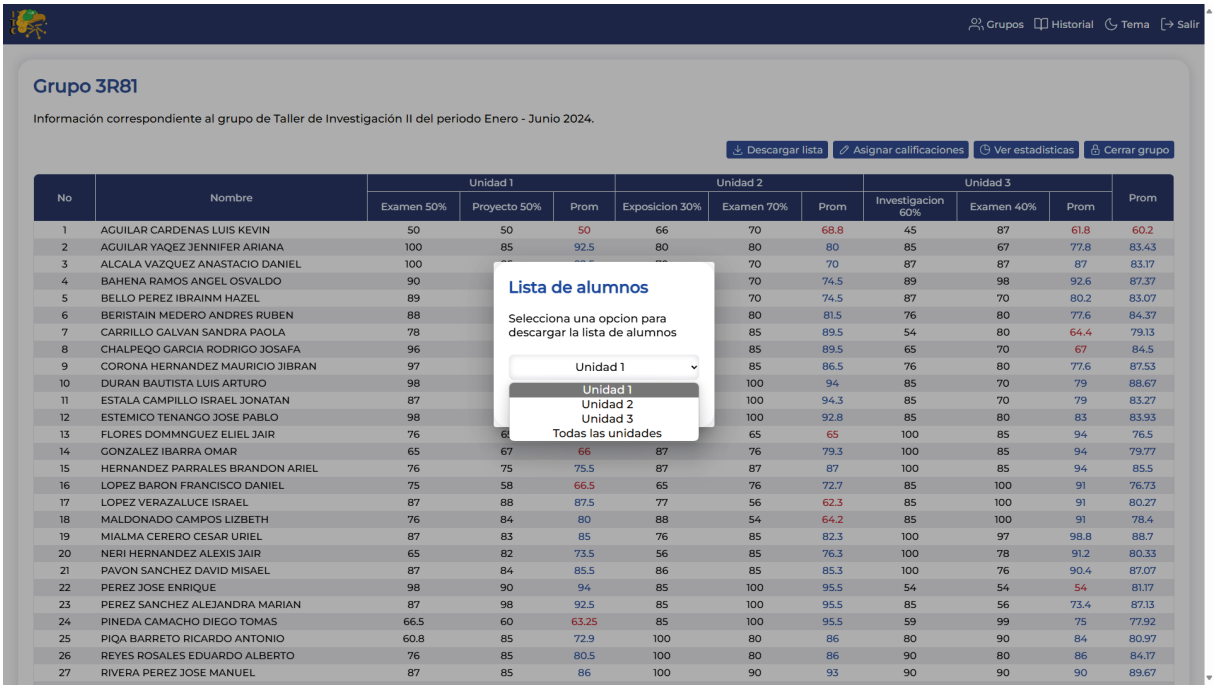


No	Nombre	Unidad 1			Unidad 2			Unidad 3			Prom
		Examen 50%	Proyecto 50%	Prom	Exposicion 30%	Examen 70%	Prom	Investigacion 60%	Examen 40%	Prom	
1	AGUILAR CARDENAS LUIS KEVIN	0	0	0	0	0	0	0	0	0	0
2	AGUILAR YAQEZ JENNIFER ARIANA	0	0	0	0	0	0	0	0	0	0
3	ALCALA VAZQUEZ ANASTACIO DANIEL	0	0	0	0	0	0	0	0	0	0
4	BAHENA RAMOS ANGEL OSVALDO	0	0	0	0	0	0	0	0	0	0
5	BELLO PEREZ IBRAINM HAZEL	0	0	0	0	0	0	0	0	0	0
6	BERISTAIN MEDERO ANDRES RUBEN	0	0	0	0	0	0	0	0	0	0
7	CARRILLO GALVAN SANDRA PAOLA	0	0	0	0	0	0	0	0	0	0
8	CHALPEQO GARCIA RODRIGO JOSAFA	0	0	0	0	0	0	0	0	0	0
9	CORONA HERNANDEZ MAURICIO JIBRAN	0	0	0	0	0	0	0	0	0	0
10	DURAN BAUTISTA LUIS ARTURO	0	0	0	0	0	0	0	0	0	0
11	ESTALA CAMPILLO ISRAEL JONATAN	0	0	0	0	0	0	0	0	0	0
12	ESTEMICO TENANGO JOSE PABLO	0	0	0	0	0	0	0	0	0	0
13	FLORES DOMMNGUEZ ELIEL JAIR	0	0	0	0	0	0	0	0	0	0
14	GONZALEZ IBARRA OMAR	0	0	0	0	0	0	0	0	0	0
15	HERNANDEZ PARRALES BRANDON ARIEL	0	0	0	0	0	0	0	0	0	0
16	LOPEZ BARON FRANCISCO DANIEL	0	0	0	0	0	0	0	0	0	0
17	LOPEZ VERAZALUCE ISRAEL	0	0	0	0	0	0	0	0	0	0
18	MALDONADO CAMPOS LIZBETH	0	0	0	0	0	0	0	0	0	0
19	MIALMA CERERO CESAR URIEL	0	0	0	0	0	0	0	0	0	0
20	NERI HERNANDEZ ALEXIS JAIR	0	0	0	0	0	0	0	0	0	0
21	PAVON SANCHEZ DAVID MISAEL	0	0	0	0	0	0	0	0	0	0
22	PEREZ JOSE ENRIQUE	0	0	0	0	0	0	0	0	0	0
23	PEREZ SANCHEZ ALEJANDRA MARIAN	0	0	0	0	0	0	0	0	0	0
24	PINEDA CAMACHO DIEGO TOMAS	0	0	0	0	0	0	0	0	0	0
25	PIQA BARRETO RICARDO ANTONIO	0	0	0	0	0	0	0	0	0	0
26	REYES ROSALES EDUARDO ALBERTO	0	0	0	0	0	0	0	0	0	0
27	RIVERA PEREZ JOSE MANUEL	0	0	0	0	0	0	0	0	0	0

Figure 4. Group page with students. Own elaboration.

No	Nombre	Unidad 1			Unidad 2		Unidad 3	
		examen	tareas	investigacion	examen	proyecto	examen	inv
1	AGUILAR CARDENAS LUIS KEVIN	91	87	90	66	76	71	
2	AGUILAR YAQEZ JENNIFER ARIANA	80	76	70	90	50	60	
3	ALCALA VAZQUEZ ANASTACIO DANIEL	100	100	100	100	100	50	
4	BAHENA RAMOS ANGEL OSVALDO	90	99	76	100	100	99	

Figure 5. Page for capturing grades. Own elaboration.



No	Nombre	Unidad 1			Unidad 2			Unidad 3			Prom
		Examen 50%	Proyecto 50%	Prom	Exposicion 30%	Examen 70%	Prom	Investigacion 60%	Examen 40%	Prom	
1	AGUILAR CARDENAS LUIS KEVIN	50	50	50	66	70	68.8	45	87	61.8	60.2
2	AGUILAR YAQEZ JENNIFER ARIANA	100	85	92.5	80	80	80	85	67	77.8	83.43
3	ALCALA VAZQUEZ ANASTACIO DANIEL	100				70	70	87	87	87	83.17
4	BAHENA RAMOS ANGEL OSVALDO	90				70	74.5	89	98	92.6	87.37
5	BELLO PEREZ IBRAINM HAZEL	89				70	74.5	87	70	80.2	83.07
6	BERISTAIN MEDERO ANDRES RUBEN	88				80	81.5	76	80	77.6	84.37
7	CARRILLO GALVAN SANDRA PAOLA	78				85	89.5	54	80	64.4	79.13
8	CHALPEQO GARCIA RODRIGO JOSAFA	96				85	89.5	65	70	67	84.5
9	CORONA HERNANDEZ MAURICIO JIBRAN	97				85	86.5	76	80	77.6	87.53
10	DURAN BAUTISTA LUIS ARTURO	98				100	94	85	70	79	88.67
11	ESTALA CAMPILLO ISRAEL JONATAN	87				100	94.3	85	70	79	83.27
12	ESTEMICO TENANGO JOSE PABLO	98				100	92.8	85	80	83	83.93
13	FLORES DOMMNGUEZ ELIEL JAIR	76	6			65	65	100	85	94	76.5
14	GONZALEZ IBARRA OMAR	65	67	66	87	76	79.3	100	85	94	79.77
15	HERNANDEZ PARRALES BRANDON ARIEL	76	75	75.5	87	87	87	100	85	94	85.5
16	LOPEZ BARON FRANCISCO DANIEL	75	58	66.5	65	76	72.7	85	100	91	76.73
17	LOPEZ VERAZALUCE ISRAEL	87	88	87.5	77	56	62.3	85	100	91	80.27
18	MALDONADO CAMPOS LIZBETH	76	84	80	88	54	64.2	85	100	91	78.4
19	MIALMA CERERO CESAR URIEL	87	83	85	76	85	82.3	100	97	98.8	88.7
20	NERI HERNANDEZ ALEXIS JAIR	65	82	73.5	56	85	76.3	100	78	91.2	80.33
21	PAVON SANCHEZ DAVID MISAEL	87	84	85.5	86	85	85.3	100	76	90.4	87.07
22	PEREZ JOSE ENRIQUE	98	90	94	85	100	95.5	54	54	54	81.17
23	PEREZ SANCHEZ ALEJANDRA MARIAN	87	98	92.5	85	100	95.5	85	56	73.4	87.13
24	PINEDA CAMACHO DIEGO TOMAS	66.5	60	63.25	85	100	95.5	59	99	75	77.92
25	PIQA BARRETO RICARDO ANTONIO	60.8	85	72.9	100	80	86	80	90	84	80.97
26	REYES ROSALES EDUARDO ALBERTO	76	85	80.5	100	80	86	90	80	86	84.17
27	RIVERA PEREZ JOSE MANUEL	87	85	86	100	90	93	90	90	90	89.67

Figure 6. Dialog to download list of qualifications . Own elaboration

TECNOLÓGICO NACIONAL DE MÉXICO

INSTITUTO TECNOLÓGICO DE CUAUTLA

SISTEMA WEB DE MONITOREO EDUCATIVO ENFOCADO A ÍNDICES DE REPROBACIÓN Y DESERCIÓN ESCOLAR

DEPARTAMENTO: **Sistemas computacionales**
MATERIA: **Taller de Investigación II**
PROFESOR: **Leonor Ángeles Hernandez**
PERIODO: **Enero - Junio 2024**

GRUPO: **1**
UNIDAD: **1**
CLAVE: **3R8**
ALUMNOS: **34**

No.	Nombre	Act1	Act2	Promedio
1	AGUILAR CARDENAS LUIS KEVIN	50	50	50.00
2	AGUILAR YAQEZ JENNIFER ARIANA	100	85	92.50
3	ALCALA VAZQUEZ ANASTACIO DANIEL	100	85	92.50
4	BAHENA RAMOS ANGEL OSVALDO	90	100	95.00
5	BELLO PEREZ IBRAINM HAZEL	89	100	94.50
6	BERISTAIN MEDERO ANDRES RUBEN	88	100	94.00
7	CARRILLO GALVAN SANDRA PAOLA	78	89	83.50
8	CHALPEQO GARCIA RODRIGO JOSAFA	96	98	97.00
9	CORONA HERNANDEZ MAURICIO JIBRAN	97	100	98.50
10	DURAN BAUTISTA LUIS ARTURO	98	88	93.00
11	ESTALA CAMPILLO ISRAEL JONATAN	87	66	76.50
12	ESTEMICO TENANGO JOSE PABLO	98	54	76.00
13	FLORES DOMMNGUEZ ELIEL JAIR	76	65	70.50
14	GONZALEZ IBARRA OMAR	65	67	66.00
15	HERNANDEZ PARRALES BRANDON ARIEL	76	75	75.50
16	LOPEZ BARON FRANCISCO DANIEL	75	58	66.50
17	LOPEZ VERAZALUCE ISRAEL	87	88	87.50
18	MALDONADO CAMPOS LIZBETH	76	84	80.00
19	MIALMA CERERO CESAR URIEL	87	83	85.00
20	NERI HERNANDEZ ALEXIS JAIR	65	82	73.50
21	PAVON SANCHEZ DAVID MISAEL	87	84	85.50
22	PEREZ JOSE ENRIQUE	98	90	94.00
23	PEREZ SANCHEZ ALEJANDRA MARIAN	87	98	92.50
24	PINEDA CAMACHO DIEGO TOMAS	66.5	60	63.25
25	PIQA BARRETO RICARDO ANTONIO	60.8	85	72.90
26	REYES ROSALES EDUARDO ALBERTO	76	85	80.50
27	RIVERA PEREZ JOSE MANUEL	87	85	86.00
28	RODRIGUEZ AQUINO AXEL NOE	85	100	92.50
29	RUIZ GALLARDO MIGUEL ANGEL	85	100	92.50
30	SIERRA TORRES OSCAR	85	100	92.50
31	TOLEDANO GALICIA KAROLINA	100	85	92.50
32	VASQUEZ GALINDO ALAN DANIEL	100	85	92.50
33	VAZQUEZ FLORES CHRISTIAN NAIM	100	85	92.50
34	ZAYAS JIMENEZ ABRAHAM	0	0	0.00

Alumnos aprobados	29	85.29%
Alumnos reprobados	4	11.76%
Alumnos desertados	1	2.94%
Total	34	100%

Firma del profesor

Este documento no es válido si tiene tachaduras o enmendaduras

Yecapixtla, Morelos a 23-05-2024

Figure 7. PDF file of unit grades. Own elaboration.

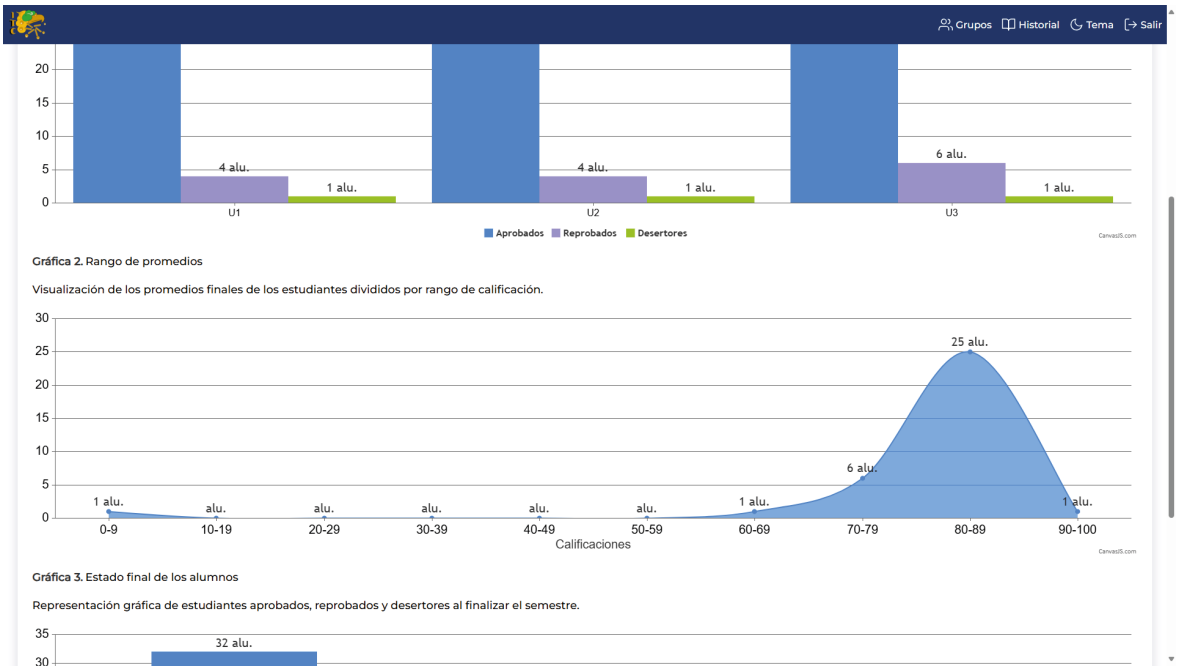


Figure 8. Statistics and graphs page of the group . Own elaboration.

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