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Design and Implementation of an Extranet Web Application for Collaborative Education at the Faculty of Sciences and Techniques – Comoros

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ABSTRACT

This paper presents an interactive e-learning web platform for the Faculty of Sciences and Techniques, University of Comoros. This Extranet application replaces the manual Excel processing during session examination by proposing a fully automated programming application. The proposed platform helps to minimize errors that occur when using Excel manipulation, students' interaction with the department, and waiting time before a response. The application leads also to a centralization of the results after deliberation and students can consult their detailed results over the different islands without having to come back to the campus. For the security of the developed platform, we used the well-known efficient agile method that allows us to facilitate task management during the process. The full platform was designed using the UML, and the implementation was done under object-oriented programming. The system was built using PHP, HTML, CSS, Symfony, JavaScript, and MySQL. For the Extranet considerations, all users are given a non-modifiable username and a unique password to access the application. During the testing period, the administration service was able to accept student requests such as reports and attestation, and scores claiming and students were automatically notified of the evolution of their requests.

INTRODUCTION

High school colleges face various challenges related to communication, information dissemination, and administrative processes. Traditional methods of managing such tasks through paper-based systems or outdated software often result in inefficiency and reduced engagement among stakeholders. Educational departments have to manage and to secure databases that may contain thousands of rows with sensible information such as students' personal information. With the vulgarization of the new technologies, many educational centers proposed the use of web or intranet applications instead of using Excel files or manually managing this information (Josette, 2017; Schwabe *et al.*, 2004; Wu *et al.*, 2019). During the pandemic of the Covid-19, e-learning programs are developed and adopted (Adedoyin & Soykan, 2023; Bajao *et al.*, 2022; Rizada & Rey, 2023; Singh *et al.*, 2023) to face to human restrictions and in-site courses suspended. Among those solutions, interactive web applications can offer a viable solution to overcome these challenges and streamline day-to-day operations.

The Faculty of Sciences and Techniques of the University of Comoros is created in 2003. During the first ten years, the Faculty had only two bachelor formations, and the number of students was less than 500. Therefore, using Excel software in order to collect different notes of modules, calculate means, print results, reports and attestations was easy to control and errors were detected without high effort. Over the years, numerous formations have been introduced. The faculty has now six bachelor degree formations, and four master degree formations. The number of registered students increases with the multiplication and the diversification of the formations in the faculty. Using Excel software became heavy and many cases of errors occur very often after results publication. Students' score claims are intensive, and the educational department was overwhelmed. Moreover, Excel files were heavier and simpler to management; scores claiming treatment or name modification demanded more and more time to save the modified file. In addition, since the world pandemic disease of Coronavirus in 2020, the number of students in the faculty increased exponentially and Excel software seems unappropriated for the examination process. The Excel application has reached its real limits during this period.

Thus, alternative solutions were proposed to replace the use of Excel software in the examination process. All the proposed solutions were commercial and were not adapted to the needs of the faculty at 100 percent. Thus, we proposed a local solution developed by a local team of students and local advisors. This solution is freely developed and totally maintained by the local resources. The first version of the solution, used during the academic years of 2020-2021 and 2021-2022, was an internet web application which allowed the administration of the faculty to reduce the errors caused when using Excel application and to speed up the process of the results centralization. The first version of the application was developed speedily given the emergency of the needs. In the first version, many challenges were not fixed. For instance, to treat student's score claiming, the administrators had to re-upload the all the database

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because the application used a static database. All the means and calculated notes were simply readied by the application. After the publication of the results, student were required to return to the campus of the college for simple score claiming.

Numerous solutions based on web applications were proposed in different countries (Bajao *et al.*, 2022; Love, 2018). For example, in Niger, a Web application was designed and implemented for the Baccalaureate Grade processing since 2018 (Kachalo *et al.*, 2018). Standard websites are usually designed for an informative and promotional issue. This conventional website is not appropriate for an interactive e-learning application. The web application is a website that can lead students, teachers, and administrators to exchange in an online platform. Extranet Web applications can be accessed from every region of the world via Internet services using personal identification. This kind of application gives the student flexibility to return to their regions or islands after the end of the annual evaluations. From home, students can access their own results, send requests, and eventually submit a score claim. This new web application is named "Schooling Web service". The full platform is modeled using the Unified Modeling Language (UML) (Unhelkar, 2017), designed by the HTML and CSS technologies (Duckett, 2011; Nebra, 2023) and the implementation is done under object oriented programming using PHP, JavaScript and MySQL (Nebra & Andrieu, 2022; Nixon, 2022; Thuillier, 2017). To secure the developed web application, Symfony 5 is preferred (Potencier, 2019).

The development of the interactive web application follows an iterative and user-centric approach. The team involved in this project comprised software engineers, designers, educators, and stakeholders from the faculty center. The methodology included the following key steps. The requirement gathering to understand the needs and expectations of the users is presented in the Subsection Analyzing of the system. The design, prototyping and development are outlined in the subsection Design, prototyping and implementation while Section RESULTS AND EVALUATIONS concerns to the results, deployment and testing of the application.

MATERIALS AND METHODS

Analyzing of the System

The initial phase involved extensive stakeholder engagement to gather user requirements and expectations from the web application. Surveys, interviews, and focus group discussions were conducted to obtain insights into the specific needs and pain points of each user group regrouped into three parts: students, teachers and administrators.

The flowchart from Figure 1 outlines the main steps and functionalities of the proposed e-learning web application (Vazquez-Peñaloza & Jaimez-González, 2019). The flowchart starts with the "Start" point where the user initiates the process. The user is then prompted to log in with his credentials to access the e-learning platform. After successful login, the user is directed to the "Dashboard" as the central navigation hub. From the dashboard, according to his profile, the user can "Select Course" to browse, add course or evaluation, print reports, etc.

Once a student selects a course, the user can "View Course Content," which includes lectures, documents, and other study materials. Students can also send an examination report related to the course before the deadline. Connected teachers can access their "Profile" to update personal information or settings. If the user wishes to leave the platform, they can "Logout." The flowchart also includes a feedback loop in the discussions, where users can provide feedback or suggestions to improve the platform.

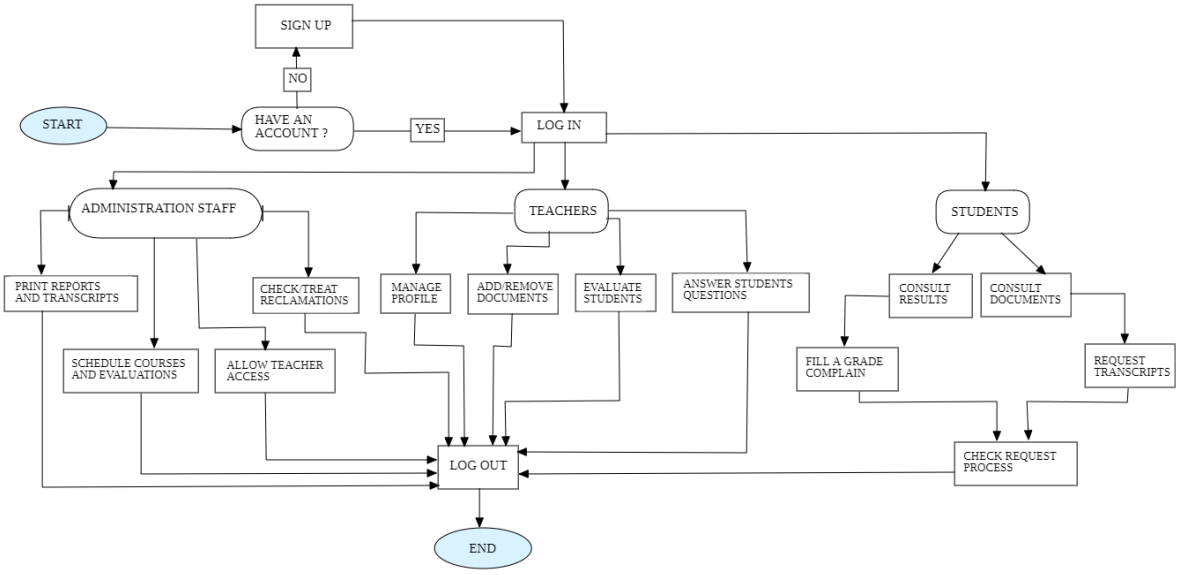

Figure 1: The System Flowchart summarizing the main steps and functionalities of the proposed application

The use case diagram represents the interactions between users and the system. There exists two different types of Data Flow Diagram (DFD) (Aleryani, 2016; Li & Chen, 2009). Here we select the context-level DFD (level 0), where the main application is represented by a simple box, and only flows outside the domain are reported. Figure 2 outlines the simplified Data Flow Diagram (DFD) level 0 (the context diagram) for the proposed e-learning web application that shows the three main users of the platform.

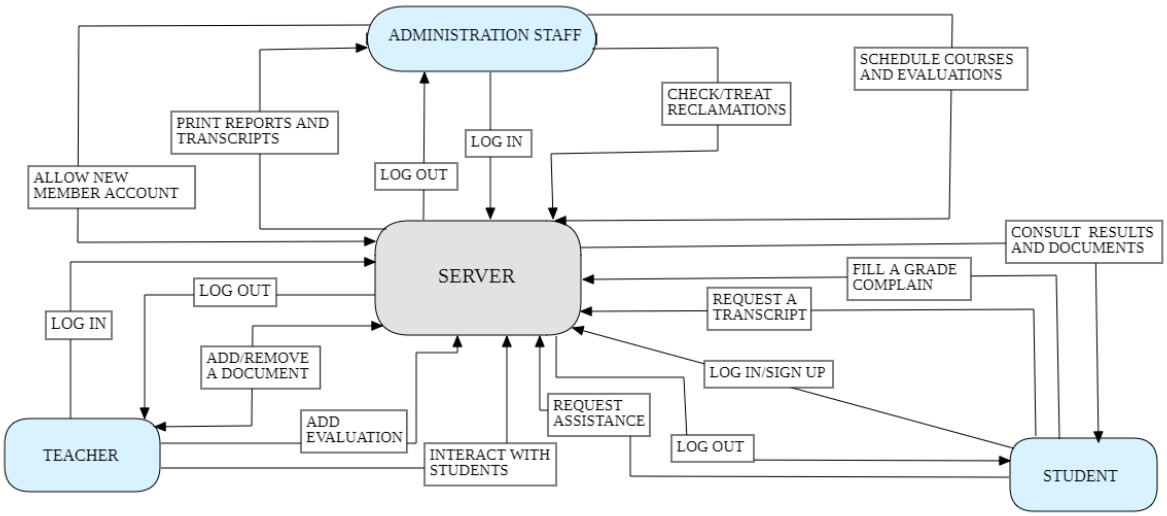

Figure 2: Data Flow Diagram of the proposed e-learning application

Design, Prototyping and Implementation

Based on the gathered requirements, the application's architecture and user interface were designed. Multiple iterations of prototyping were performed to validate design choices and gather feedback from potential users.

The web application was developed using modern web technologies, including HTML5, CSS3, JavaScript, and Angular for the frontend. The backend was built using Symfony 5, PHP, and a relational database (MySQL) to store user data and application records.

The development process followed agile methodologies, enabling iterative feature additions and frequent testing. Extensive testing, including unit testing and user acceptance testing, was conducted to ensure the application's functionality and performance. The application incorporated a robust authentication system, enabling secure login for students, teachers, and administrative staff. Role-based access control ensured that each user group could access only the relevant features and functionalities.

Teachers could create and manage course materials, syllabi, assignments, and resources through a user-friendly interface. Students had easy access to all course-related information and could submit assignments digitally. The application provided real-time messaging and discussion forums, enabling seamless communication between students and teachers. It facilitated group collaborations and allowed teachers to send announcements and

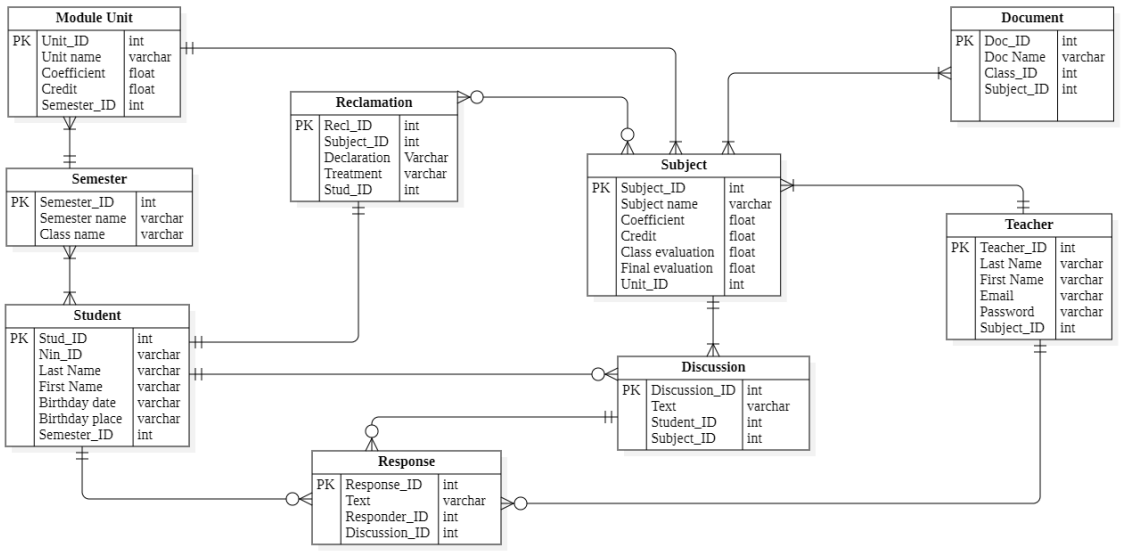

Figure 3: Conception of the application: The Entity-Relationship Diagram for the database

notifications. Administrative staff could manage student records, track attendance, generate reports, and handle scheduling through dedicated administrative tools. The database is organized according to the conceptual data model presented in Figure 3.

As the web application handles sensitive information, ensuring data security and privacy is of paramount importance. This was a top priority during development. Encryption protocols and secure APIs were implemented to safeguard sensitive information. As the number of users increased, the application's performance became a concern. Employing scalable cloud infrastructure and optimizing database queries addressed scalability challenges.

RESULTS AND EVALUATION

The web application was deployed on a scalable web server, allowing smooth access to users. The section discusses future enhancements and potential areas for expansion, including integration with other educational platforms, feedback mechanisms, and continuous improvement of user experience.

The interactive web application was subjected to rigorous user testing and evaluation. Users reported increased satisfaction with the improved communication and accessibility. Administrative staff experienced enhanced efficiency in managing records and processes. The application's performance and responsiveness met user expectations. The proposed web application offers a range of features to cater to different stakeholders:

Student Portal

Enabling students to access course materials, grades, and assignments, and facilitating collaboration with classmates and teachers.

Faculty Portal

Empowering faculty members to manage courses, grade assignments, and communicate with students efficiently.

Staff Portal

Streamlining administrative tasks, such as managing student records, scheduling events, and handling admissions.

Calendar and Notifications

Implementing a comprehensive calendar system with event scheduling and automated reminders.

To guarantee the application's reliability and functionality, comprehensive testing procedures were conducted, including unit testing, integration testing, and user acceptance testing.

Students Interface

In the ever-evolving landscape of education, students have found a profound connection to the e-learning website (Coman *et al.*, 2020). The proposed platform serves as virtual gateway to knowledge, offering a myriad of benefits that resonate with the modern learner. First and foremost, the convenience and flexibility of accessing educational content anytime, anywhere have revolutionized the learning experience. With a diverse range of courses and subjects at their fingertips, students can tailor their learning journey to suit their interests and goals. The interactive nature of this e-learning website fosters a deeper understanding of the material and enhances retention. Moreover, the ability to track progress, receive personalized feedback, and connect with a global community of learners and instructors creates a sense of accountability and motivation. As e-learning continues to innovate and expand, students find themselves seamlessly integrated into this virtual realm of education, propelling them toward academic excellence and personal growth.

In Figure 4, the profile page of the faculty students is shown and how they can add or edit their information. Whether they can upload a picture to their profile. They can view all their registered information and their results while these ones are available. Students can also from their profile access to the discussions, search and download

Figure 4: Students profile: The connection page (left) and the homework submission (right)

documents according to modules they are registered and interacting with the faculty administration.

Administrators Interface

Approving student's score claiming for their school report on the platform involves a systematic and evidence-based approach by the administrator. When a student submits a score claiming request, the administrator must gather all relevant data pertaining to the assessment process. This includes accessing the original school report, the grading rubric or guidelines used, and any additional feedback or comments provided by the teacher or evaluator.

Next, the administrator should carefully examine the student's score claiming and assess it against the established grading criteria. Applying scientific principles such as objectivity and consistency, the administrator must ensure that the score claiming request is treated impartially, regardless of the student's identity or personal circumstances.

In order to make an informed decision, the administrator may need to collaborate with the teacher or evaluator who assessed the report initially. Open communication and sharing of perspectives can help in understanding the rationale behind the original grading and whether the score claiming request is valid.

Furthermore, the administrator should keep a detailed record of the steps taken during the score claiming review process, documenting all relevant information and the reasoning behind the final decision. This documentation is essential for transparency and accountability purposes. Additionally, the platform includes clear guidelines and policies in place to govern the score claiming treatment process, ensuring that it aligns with scientific principles and best practices in education assessment. Regular training and professional development for administrators can also enhance their expertise in handling score claiming requests effectively.

By adhering to a scientific approach in approving student's score claiming for their school report, the administrator can maintain fairness, accuracy, and reliability in the assessment process, ultimately fostering a supportive and conducive learning environment on the platform. To ensure transparency, all the score claiming treatment process is controlled by two administrators: the chief of the concerned department who check all the verification process and propose the corresponding note. The proposed note is not effective until approved by the head of schooling. Figure 5 and Figure 6 show the two steps of the score claiming treatment process and validation.

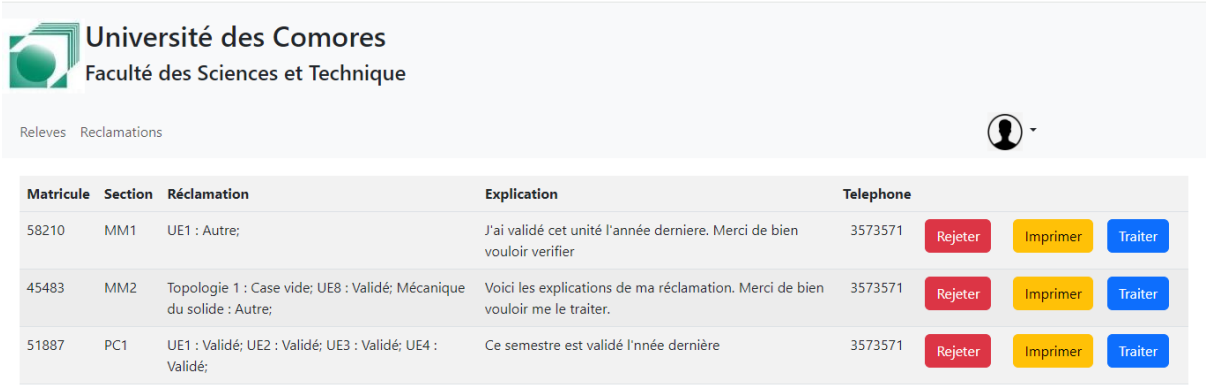

Figure 5: Score claiming process at the department head: rejection, printing report or treatment of a checked claim

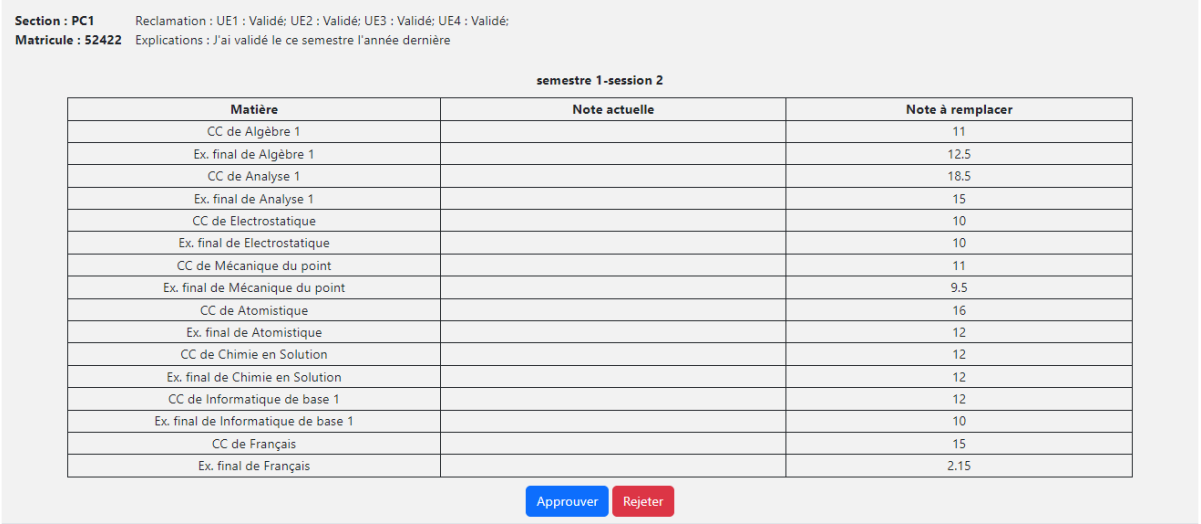

Figure 6: Claim validation at the schooling department head

CONCLUSIONS

In this paper, a new version of an extranet web application is designed and implemented for the faculty of sciences and techniques, University of Comoros. The first test carried out over the past three years have shown that the proposed application is well adapted on the needs of the college and allows first management of the examination process. Students do no more needs to come back to the campus for simple demands and/or scores claiming. They can stay home, in their island and send their request. While the request is treated, an automatic message is sent to the corresponding score claimer so that he can be informed to the evolution of his demand.

The design and implementation of this interactive web application proved to be a successful endeavour. The application's user-friendly interface, coupled with its robust functionality, significantly improved communication, engagement, and administrative efficiency. As technology continues to evolve, ongoing enhancements and updates will further optimize the application's performance and cater to the changing needs of the educational landscape. The study demonstrates the immense potential of interactive web applications in transforming educational institutions and fostering a collaborative learning environment.

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