

PNRRorienta: A Web Application for Managing Schools, Courses, and Students Involved in the PNRR Orientation Initiative

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Abstract

The *National Recovery and Resilience Plan (PNRR)* allocates funds to universities for participating in an initiative for delivering orientation courses to students in the last three years of secondary education. The University of Padua is among the institutions joining this initiative.

The main objective of these courses is to help students understand the significance of higher education and its value to society. These courses also provide students with an opportunity to explore different educational offerings. Additionally, students can gain practical experience in active and laboratory-based disciplinary teaching, consolidate their knowledge, and develop reflective and transversal skills. Finally, students can also get an overview of various employment sectors and potential job prospects.

However, this initiative requires a big effort to plan all the lectures and manage the huge amount of students, institutes, courses, and professors involved. Therefore, in this work we present a Web application, called *PNRRorienta*, we have designed and developed to manage and simplify all the tasks related to this initiative. The University of Padua has started to use this application in September 2023 and, as of February 2024, it handles more than 70 different secondary education institutes in the Veneto Region, almost 200 courses offered to students, more than 1,300 lectures, more than 400 professors, and almost 10,000 students actively enrolled.

Keywords

Web Application, Management System, PNRR, Orientation

1. Introduction

In the last three years of secondary school, students face a crucial moment in which they need to take decisions that will shape their educational future and, ultimately, their job and career opportunities. Thus, it is fundamental to support students in taking informed and careful decisions about the path to follow for their future. To this end, the *National Recovery and Resilience Plan (PNRR)* allocates funds to universities for organizing and offering specific

SEBD 2024: 32nd Symposium on Advanced Database Systems, June 23-26, 2024, Villasimius, Sardinia, Italy

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orientation courses that support students in understanding the importance of higher education in our society but also introduce them to the world of work and its employment sectors¹.

Many universities are committed to this initiative and the University of Padua is among them, strongly believing that through this initiative students can be guided in their path towards a fulfilling future, contributing to both personal satisfaction and societal advancement.

However, this initiative calls for many different stakeholders – students, staff at secondary education institutes, administrative staff at universities, and professors – and requires a big effort to organize, offer, and deliver courses involving so many actors. As a consequence, it is hardly feasible to manage the whole process in a “manual way”, because of the amount of data, the risk of errors and inconsistencies, and the excessive load and effort required. However, while CINECA has developed for the Ministry of University and Research a Web application where to submit and report the activities conducted by Universities to be granted the corresponding funding, to the best of our knowledge, there is no application readily available for universities to help them to organize, manage, and deliver the orientation courses and to collect the data required for the administrative reporting to the Ministry.

Therefore, we designed and developed the *PNRRorienta*² Web application, which the University of Padua has recently adopted to address the needs raised by then PNRR orientation initiative. PNRRorienta has been co-designed together with the various stakeholders involved and it has undergone continuous refinements in collaboration with domain experts, ensuring adjustments and customizations based on their valuable feedback.

PNRRorienta automates many of the tasks required for collecting, managing, and sharing the required data among all the involved stakeholders, as well as with formal obligations, such as the signature of an agreement between the university and each secondary education institute. It can be seen as a sort of intermediary between the University of Padua, the secondary education institutes, and the professors with the purpose of streamlining and improving communication and data exchange, also featuring a user-friendly interface that allows for easy interaction with the system.

PNRRorienta has been tailored to specifically fulfill the procedures and rules required by the PNRR orientation initiative and it could be useful also for other Italian universities participating in it. Moreover, thanks to its modular design, it could be easily extended and further adapted to the specific needs of other universities.

The paper is organized as follows: Section 2 introduces related works; Section 3 discusses the system’s requirements; Section 4 shows the design and implementation of the Web application; Section 6 presents some statistics regarding the usage of the system; finally, Section 7 draws some conclusions and outlooks some future work.

¹More information on “Investimento 1.6 Orientamento attivo nella transizione scuola-università” are available at: <https://www.mur.gov.it/it/pnrr/misure-e-componenti/m4c1/investimento-16-orientamento-attivo-nella-transizione>.

²<https://pnrrorienta.unipd.it/>

2. Related Works

2.1. Moodle

Nowadays, most universities rely on *Learning Management System (LMS)* and e-learning platforms to create, deliver, and manage online courses and learning environments [1]. In this context, Moodle is an open-source e-learning platform, that is used by several institutions around the world, and provides a virtual learning environment that fosters collaborative participation among students and interaction between students and teachers [2].

The University of Padua is one of the many institutions that adopted this platform to offer and manage its courses. Although Moodle is a modular and flexible platform, it is not suitable for satisfying all the requirements and features needed for the PNRR orientation initiative. Indeed, most of the required functionalities are either only partially supported by existing components, which would lead to contrived workflows and practices, or call for deep adaptation and modification of the platform, which would demand substantial development effort, still leading to a sub-optimal solution. For these reasons, we have decided to not rely on Moodle for developing PNNRorienta.

2.2. Customer Relationship Management Systems

Customer Relationship Management (CRM) systems are another potential candidate for executing the PNRR orientation initiative since they are used to automate and improve business processes [3]. Among them, SAP (Systems, Applications, and Products) is a leading solution that integrates various business functions into a unified platform and helps organizations manage their operations, including finance, sales, inventory, human resources, and more, in a streamlined and efficient manner. As an alternative to SAP, Salesforce is a cloud-based CRM platform that offers a suite of applications designed to help businesses manage and streamline their sales, marketing, customer service, and other functions.

Despite being leading market solutions, both SAP and Salesforce were deemed not suitable for the purposes of the PNRR orientation initiative. First, they are proprietary solutions with high adoption costs. Secondly, they are extremely huge and complex systems, quite oversized for the actual requirements and needs of the PNRR orientation initiative. Thirdly, as in the case of Moodle, they would have required further adaptation and customization, only to partially fulfill the requirements.

2.3. Web Development Frameworks

There are various programming languages and frameworks that can be used to develop Web applications. Considering the Python programming language, Flask and Django are two of the most popular options: Django [4] is a simple, robust, and flexible framework that allows developers to build Web applications with ease and without much overhead; Flask [5] is a small but powerful and extensible micro-framework, consisting of core services and pluggable extensions, which streamline the development and provide off-the-shelf components ready to use.

3. Requirements

We briefly describe the overall main requirements specified by the domain experts for the PNRROrienta Web Application:

1. provide a database to record and store all the required data;
2. upload, process, and export data via spreadsheets. Some spreadsheets will subsequently be uploaded to the official platform of the Ministry of University and Research in order to monitor and report the activities of each university;
3. develop a user-friendly interface that allows staff at both universities and secondary education institutes to easily interact with the application;
4. provide separated areas for users belonging to the staff of the university and of the secondary education institutes. These areas are accessible via login by users with a given role, who can perform only actions specific to their role;
5. allow secondary education institutes to register themselves in PNRROrienta to book courses and to record the attendance of students to courses. Institutes are represented by one or more representative teachers, responsible for performing all the expected activities, like booking courses, enrolling students, signing agreements, and so on;
6. automatically generate the agreements to be signed by the university and the secondary education institutes as well as the reports and documentation required by the Ministry;
7. send automatic e-mails when some specific actions are performed, e.g., registration of an institute, insertion of a lecture, and so on;

Here we summarize some of the main additional constraints that need to be met:

1. each course is composed of several modules (for a total duration of 15 hours) and is offered according to several possible editions, i.e., each edition of a course represents a different period in which the course is delivered;
2. each module has a specific duration, can be taught by one or more professors, and can belong to different courses;
3. all the lectures must be associated with a specific module of an edition of a course and can be taught by some or all the professors assigned to the module;
4. each secondary education institute can consist of different related schools and each institute has one or more representative teachers who are in charge of interacting with the Web Application, e.g., booking courses, enrolling students, and so on;
5. each institute can reserve course editions and enroll students once bookings are confirmed;
6. each student can be subscribed *only* to one of the editions of the courses during the overall initiative. Each student belongs to a given institute and to a corresponding related school;
7. all agreements are associated with a given secondary education institute and must be duly signed.

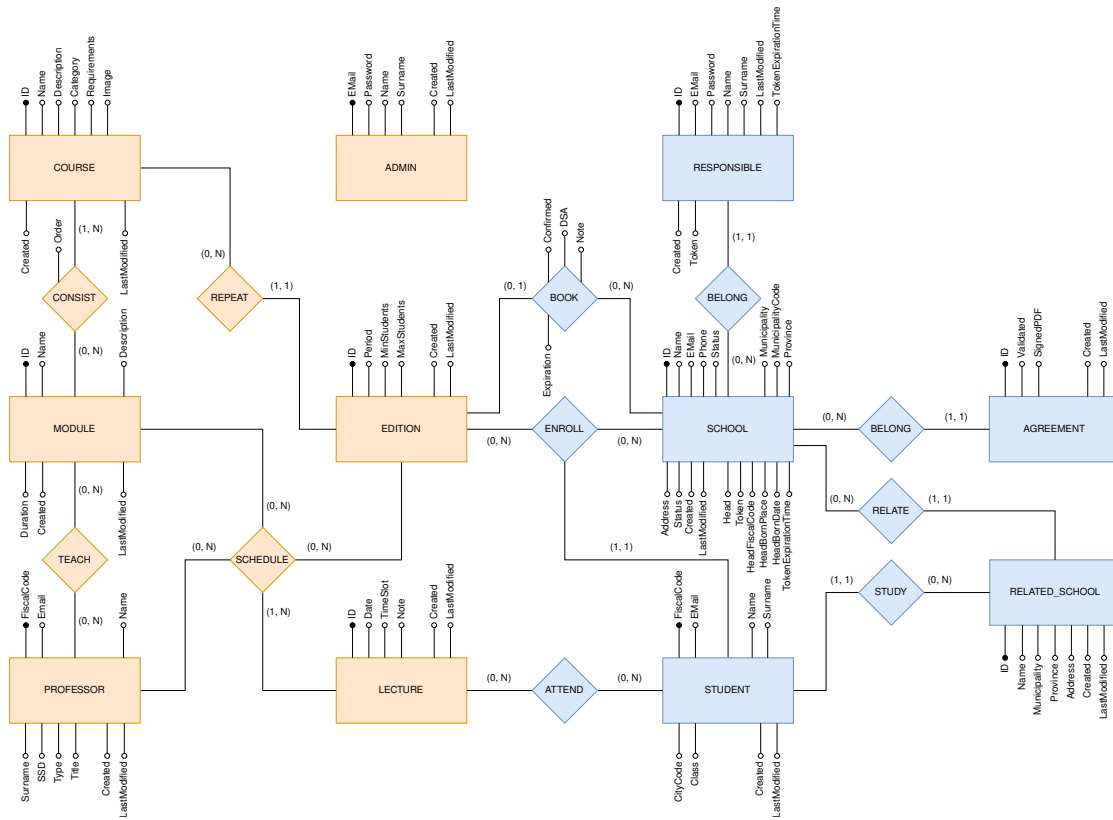


Figure 1: The conceptual schema with all the entities and their relationships.

4. Design and Development of PNRROrienta

4.1. Conceptual Schema

Figure 1 shows the conceptual schema of the database, discussed and refined over several iterations with our domain experts. Orange entities and relationships are mainly concerned with the university and its staff while the blue ones with secondary education institutes and their representative teachers. We briefly summarize the main features of the schema:

- each course is composed of several modules and is offered according to several possible editions. Each module can be used in different courses and is taught by one or more professors;
- each secondary education institute (the School entity in the schema) can refer to different schools and each institute has one or more representative teachers. Each school can have one or more agreements with the university and can book one or more editions of a course;
- each student can be subscribed only to one edition of a course and can belong only to one institute and to the corresponding related school;

- each lecture of an edition of a course is conducted by one or more professors associated with a given module.

We developed the database using PostgreSQL, a leading open-source, scalable, and robust database management system.

4.2. Back End and Front End

We designed our platform following the most commonly used Web standards (HTTPS, HTML, CSS, JavaScript) that ensure reliability, security, and interoperability. We also adhered to the *Representational State Transfer (REST)* paradigm [6]. We used the Django and Flask Python frameworks, discussed in Section 2.3, to develop the Web application.

Since our Web application is exposed to the Internet and its underlying database contains sensible data, we carefully analyzed the principal risks in terms of security. Therefore, we decided to apply the following countermeasures to mitigate some possible attacks:

- **Data validation:** all submitted data is validated both at the Front End and at the Back End. In this way, it is not possible to store harmful data in the database, which could compromise the overall security of the Web application.
- **Parameterized queries:** all data used in the queries to perform some operations on the database is treated as data rather than executable SQL code which could perform malicious actions. In this way it is possible to mitigate SQL injection attacks, which are one of the major causes of data breaches;
- **Cross-Site Request Forgery (CSRF) protection:** CSRF tokens are generated as a protective measure to ensure that requests originate from the intended user and not from an attacker-controlled website.

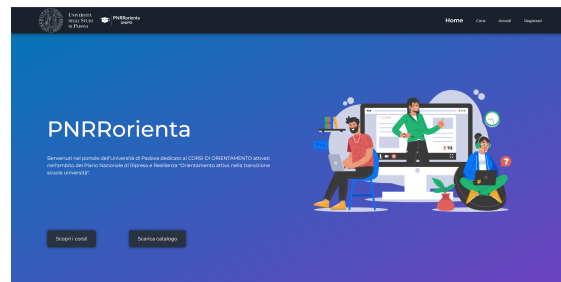
The *User Interface (UI)* has been studied and developed to be responsive, user-friendly, and animated. We highlight that the UI plays a fundamental role, as it is the primary point of interaction between users and the application itself. Responsiveness is crucial since it ensures that the application looks and functions seamlessly across different devices and screen sizes, from desktop computers to smartphones and tablets. In this way, users can easily navigate through our application, interact with its features, and access important information regardless of the device they are using, thus improving accessibility and usability.

5. The Running PNRorienta Application

In PNRorienta several Web pages allow both users and the administrative staff to perform specific actions. However, due to limited space and the presence of sensitive data, we decided to present here only some of the most relevant ones. Figure 2 provides a visual representation through screenshots of PNRorienta, capturing the user interface across both desktop and mobile platforms. In particular, Figure 2a and Figure 2b show the interface of the home Web page using different devices. Figure 2c shows the page where it is possible to browse and book courses. In this section, some modal windows can be visualized on top of the Web page to view courses



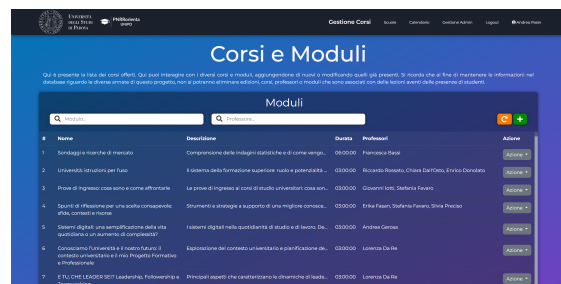
(a) Homepage visualized from a smartphone.



(b) Homepage visualized from a computer.



(c) Courses page visualized from a computer.



(d) Administrator page used to manage courses, modules, editions, and professors.

Figure 2: Some screenshots showing the design of some Web pages and their responsiveness across different devices.

more in detail and to perform bookings. Figure 2d shows a page accessible only by admins that allows them to create, modify, and delete all data related to modules, courses/editions, and professors. Also in this case, several modal windows are available to allow the administrative staff to perform specific actions according to their needs.

We remark that the Web interfaces have been designed and tailored to the specific needs of both users and the administrative staff at the University of Padua to allow for easy interaction with the platform and the data.

6. Usage Statistics

PNRRorienta was launched in September 2023 and we report some of its usage statistics, as of February 2024:

- **Courses:** 194 courses are available, comprising a total of 318 modules. Each course features 3-5 modules on average, with a cumulative count of 620 editions across all the courses;
- **Lecturers:** 424 professors and lecturers contribute to the program, delivering modules for various courses and editions resulting in a total of 1,314 lectures that have been scheduled and/or already delivered;
- **Secondary Education Institutes:** 305 institutes are present in our system, with 74 of them duly registered;
- **Students:** a total of 9,873 students are registered within the system, with attendance records tracked for each one of them;
- **Emails:** over 2,000 automated emails have been sent without the need for human intervention;
- **Agreements:** 59 agreements have been signed and uploaded into our system.

These statistics underline the importance of PNRRorienta in automating tasks and facilitating communication between the administrative staff, the professors, and the institutes.

7. Conclusions

We presented PNRRorienta, a Web application to manage the orientation courses offered by the University of Padua according to the PNRR initiative. The application has been specifically designed to manage all the tasks related to the PNRR orientation initiative.

We have discussed how we designed the system and how we implemented it according to the current standards in Web development. We have also shown that our system has been very helpful in automating several tasks and handling all the data, simplifying the work that the staff at university and secondary education institutes would have to perform otherwise.

According to the users' feedback, we will continuously refine, adjust, and improve PNRRorienta, thus enhancing its functionalities and ensuring the delivery of an optimal service both for the secondary education institutes in the Veneto region but also for the administrative staff at the University of Padua. We also hope that PNRRorienta will turn out to be a useful resource for other Italian universities participating in the PNRR orientation initiative.

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