# Arduino weather station: a radiocommunications project in Vocational Training


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***Abstract*—We present a project that consists of an application of a digital radiocommunications module developed for vocational training practices and projects. The module has been used as a transmitter and receiver of a self-designed automatic weather station. The radio link has been improved using LoRa technology, new digital sensors have been added and the microcontroller has been changed to an Arduino-compatible model. The data are stored in a LAMP server with MySQL databases. The system has been integrated into a regional educational project, has served as the basis for educational hardware and software projects, and various improvements are planned.**



***Keywords—Radiocommunications, vocational training, microcontrollers, weather station.***


## I. Introduction

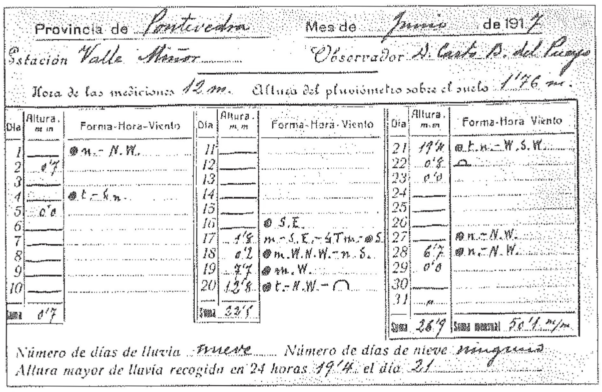
In this article, we describe an application project of the digital radiocommunications module developed for vocational training practices and projects, which was presented at the previous edition of the TAEE conference [1]. We have updated the weather station at the Escolas Proval High School (Nigrán, Spain), an automation project that began 20 years ago and continues a long tradition of meteorological observation at the school that dates back a century [2]. To do this, we used the same type of module (Fig. 1) both to send data from sensors installed in the outdoor box of the weather station and to receive and forward it to a LAMP server where it is stored in MySQL databases using PHP scripts, obtaining low response times and dissemination in near real time. The LoRa technology of the transceiver used increases the transmission distance, but also improves the reliability of the system and allows the receiver to be located almost anywhere in the school.

The previous microcontroller has been replaced by a model compatible with the Arduino environment, which allows the use of numerous existing libraries, reduces development time and facilitates future updates. The sensors have also been improved by switching to new digital models, replacing the initial ones which in some cases were still analogue technology. For educational purposes, the students have developed small hardware and software projects for reading of sensors and data transmission in different subjects of the Vocational Training Degree 'Electronic Maintenance'.

The new weather station is part of the 'Meteoescolas' educational project that we are developing during the current academic year, and currently is in the process of integration with the official meteorological service of Galicia (Meteogalicia). As improvements to the system, we are modifying the design to use new microcontroller models such as the ESP32, with greater memory capacity and Wi-Fi connectivity, while maintaining compatibility with the Arduino environment. In addition, taking advantage of the school's proximity to the coast, we plan to build a prototype of oceanographic buoy to measure new variables such as sea water temperature, wave height and tides.

## II. Project Background

The meteorological history of Val Miñor (Galicia), started in 1917 in the school created by the Unión Hispano-Americana Valle Miñor (UHAVM), an association of galician emigrants to Argentina [2]. The data were collected manually and sent by mail to the Spanish National Institute of Meteorology (INM). Some of the cards with data area still conserved, as can be seen in Fig. 1.



Provincia de Pontevedra Mes de Junio de 1917
Estación Valle Miñor Observador D. Carlos B. del Puego
Hora de las mediciones 12 m. Altura del pluviómetro sobre el suelo 1'76 m.

| Día | Altura m.m | Forma-Hora-Viento | Día | Altura m.m | Forma-Hora-Viento | Día | Altura m.m | Forma-Hora Viento |
|---|---|---|---|---|---|---|---|---|
| 1 | — | @ n.- N.W. | 11 | — | | 21 | 19'4 | @ t.n.- W.S.W. |
| 2 | 0'7 | | 12 | — | | 22 | 0'8 | |
| 3 | — | | 13 | — | | 23 | 0'0 | |
| 4 | — | @ t.- S.n. | 14 | — | | 24 | — | |
| 5 | 0'0 | | 15 | — | | 25 | — | |
| 6 | — | | 16 | — | @ S.E. | 26 | — | |
| 7 | — | | 17 | 1'8 | m.-S.E.-4Tm.-@S. | 27 | — | @ n.- N.W. |
| 8 | — | | 18 | 0'2 | @ m.W.N.W.- n.S. | 28 | 6'7 | @ n.- N.W. |
| 9 | — | | 19 | 7'7 | @ m.W. | 29 | 0'0 | |
| 10 | — | | 20 | 12'8 | @ t.- N.W.- | 30 | — | |
| | | | | | | 31 | — | |
| Suma | 0'7 | | Suma | 22'5 | | Suma | 26'9 | Suma mensual 50'1 m/m |

Número de días de lluvia nueve Número de días de nieve ninguno
Altura mayor de lluvia recogida en 24 horas 19'4 el día 21

Fig. 1. One of the cards with meteorological data (1917).

The first school was closed in 1934. Many years later, in 1980, the old building was reopened as a modern high school and the physics teacher Salvador Rodríguez Muñoz started a new meteorological project that sent also data to the INM [3]. As the new school was mainly dedicated to vocational training in electronics it was a logical step to automate the measurements, a didactic project that began in 2005 and continues today.

That first prototype was a distributed design [4] composed of a remote module placed at the external box and a second module that received data by a radio link and transferred the information to a web server [5]. The data were updated every minute and made immediately available through the web page in the form of daily tables and graphs. The remote module was powered by two small photovoltaic panels that provided enough energy both in summer and winter. That first project received an innovation award granted by the Instituto Enerxético de Galicia (INEGA) in 2007.

The elements of this first automation project (microcontroller, sensors, radio module) have been efficiently working for almost 20 years, but now they are a bit outdated and we think that should be replaced. In the new design several factors have been considered: the development of new digital sensors used in our teaching activities, the wide use of Arduino in programming education, and the availability of new digital communications modules, together with the development of the Internet of Things (IoT), that has greatly facilitated the transmission of information from remote acquisition systems, reaching distances of tens of kilometers with the most efficient technologies such as LoRa.

## III. NEW DESIGN OF THE STATION

The new design of the transmission and reception modules is based in the system described in [1], that has been used for learning purposes in the last years. An expanded module has been created, incorporating the necessary elements for interfacing the most typical weather station sensors (thermometer, hygrometer, barometer, anemometer, wind vane, rain gauge, pyranometer).

Furthermore, special attention has been paid to the solar charging system and the radio frequency layout to achieve optimal performance from all components. Fig. 2 shows the schematic of the new board, with the solar charge controllers on the left and the radio modules on the right. Each element of the system is described in detail in the following sections.

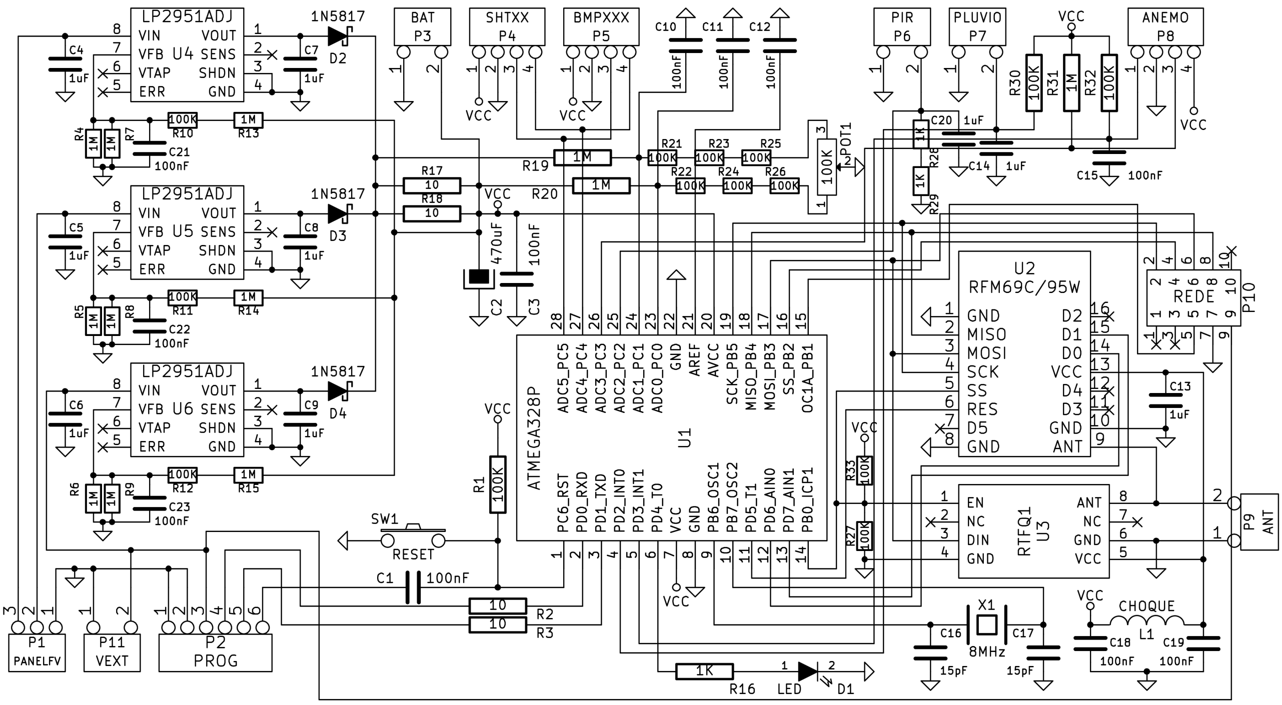



Fig. 2. Electronic schematic of the new weather station board.

### A. *Power supply and solar charger*

The old remote transmitter of the weather station was powered by solar energy and has been working a long time without almost any interruptions. The power supply consisted of two Ni-MH cells and a boost regulator that generated a constant voltage of 4.0 V. This configuration was not sufficiently protected against battery overcharging (common in summer), and the boost regulator resulted in a constant power loss, so it has been eliminated in the new design. Although solar chargers for various types of batteries are currently available on the market, we have chosen to develop our own charger for educational purposes, to improve reliability, and to minimize energy consumption. To achieve this, we have incorporated separate voltage regulators that allow for two possible separate or simultaneous power sources.

If the transmitter is connected to a computer via USB (or to a compatible external 5 V power supply), a regulator reduces the voltage to a maximum of 4.0 V to meet the specifications of the batteries, radio modules, and most digital sensors on the market.

If any of the solar panels is generating power, its associated regulator acts as a voltage limiter and charges the batteries if necessary, interrupting the charging process when the maximum voltage is reached. Having two panels with their own regulators prevents failures if one of them is shaded, dirty, or broken. This solution is better than connecting the solar panels directly in parallel to a single regulator or adding diodes, which produce additional voltage drops.

All the regulator circuits are identical and connected to the batteries. Therefore, in case of failure, any regulator can be replaced simply by changing the input connections.

The circuits are based on a LP2951 low-dropout regulator (LDO) [6]. This regulator is an adjustable model with very low self-consumption (50 μA) and voltage drop (typically 350 mV). It has a maximum input voltage of 30 V and an output current exceeding 100 mA, sufficient to charge the batteries and power the system under any circumstances, adapting to a wide variety of solar cells and power supplies. The output current is relatively low, preventing overcharging and overheating of most battery types, such as Nickel-Cadmium (Ni-Cd), Nickel-Metal Hydride (Ni-MH), Lithium-Polymer (LiPo), and others. We opted to connect three Ni-MH cells in series (typical voltage 3.6 V) due to their wider operating temperature range and because they present fewer problems in case of overcharging compared to lithium batteries.

We have not chosen switched regulators to avoid noise during the reading of analog voltages (battery voltage, analog sensors). Furthermore, all the elements (microcontroller, sensors, radio module) can be directly connected directly to the battery. This solution avoids the use of switched regulators or other elements with a significant energy consumption, like the LT1303 regulator used in the previous design.

The solar cells used have a nominal output voltage of 6 V and a current of 150 mA. To ensure continuous charging, the solar panel's voltage must be higher than that of the batteries all year round (taking into account voltage drops in the regulators, diodes, and other components). The number of solar cells could be increased to 3 or 4 for a mobile transmitter to ensure that one is always generating power, for example, if it is mounted on a buoy for measuring seawater parameters. Furthermore, to maximize energy production in winter, the solar cells have been mounted vertically, a solution that yielded excellent results in the previous design, also preventing the accumulation of water or debris.

The design proposed for this solar charger has been successfully tested and has kept the transmitter continuously operational even during a harsh winter like the current one (2025-26) with very long periods of rain and bad weather, but it will not be fully validated until it has been in operation for a full year under all possible weather conditions.

### *B. Design of the new printed circuit board*

The old weather station circuit used an RFSolutions RTFQ1-FSK radio module, which has become obsolete and will be replaced by an RFM95W module that can use either FSK or LoRa. To maintain compatibility with the current system, we designed a printed circuit board that can mount either module. Initial tests were carried out with the old module, but it has already been replaced with the new module, which allows the use of different modulation techniques. Furthermore, we designed a board that can be used for both the transmitter and the receiver, by removing or adding the necessary components.

The new design retains the main elements of the digital radio communications training module (Atmega328P-PU microcontroller and RFM95W radio transceiver) and adds the solar charger and interface circuits for the sensors, as well as the resistive networks for measuring battery voltage and charging current.

The first PCB prototypes have been assembled in the electronics laboratory of the high school (Fig. 3). All elements have been reviewed and minor design errors corrected. After that, the Gerber files were sent to an external manufacturer for the production of the final circuit boards.

Currently the prototypes manufactured at the institute are in operation. For the next academic year, after a multi-month testing period including all climatic conditions, a new design review will be conducted and the final circuit boards will be assembled.

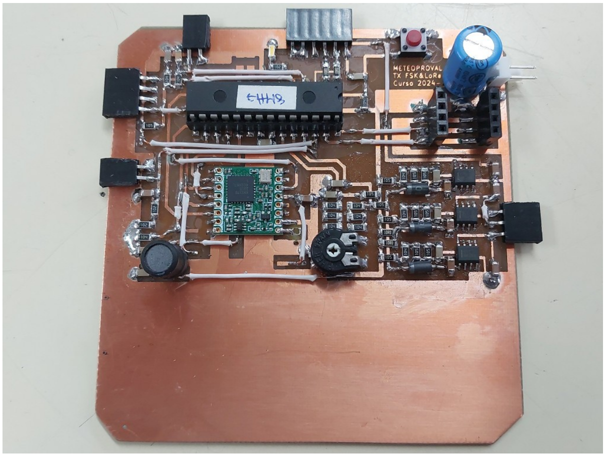


Fig. 3. First prototype of the transmitter/receiver board made at the school.

### *C. LoRa tests*

During the development of the previous radiocommunications module, a comprehensive set of tests was already conducted to verify its performance, primarily in FSK mode. With the new boards, we studied operation in LoRa mode, aiming to improve the reliability of data transmission to the server. We carried out two series of tests: the first focused on the short-range link between the weather station and the receiver located in the high school building, and the second attempted to receive data from sensors located at greater distances.

For the short-range tests, we performed transmissions in both FSK and LoRa modes. Reception was good in both cases, but LoRa allowed data reception in enclosed spaces at distances of several hundred meters, even with low dispersion factors. For this test, we used an intermediate dispersion factor (SF = 8) and a low bandwidth (BW = 62.5 kHz), resulting in a typical transmission time of 0.57 s. This time meets the 1% duty cycle requirement for LoRa systems if we plan to send data every minute (0.57 s/60 s = 0.95%). The results indicate that the receiver can be placed inside the school classrooms, protected from rain, wind, or large temperature fluctuations.

For the long-distance tests, we used LoRa with the maximum dispersion factor (SF = 12) and the minimum possible bandwidth (BW = 62.5 kHz). With these values, the amount of data must be very small (10 bytes or less) to avoid loss of synchronization between the transmitter and receiver, as the transmission time can easily exceed 4 seconds. A bandwidth lower than 62.5 kHz would be desirable, but is not recommended due to the frequency error caused by the transceiver's crystal oscillator. This problem could be solved by using a temperature-compensated crystal oscillator (TCXO). Tests demonstrated that it was possible to receive data from a point located in the port of Panxón, more than 5 km from the institute. Fig. 4 shows the elevation profile between the two points, where the lack of line of sight (LOS) is evident. This preliminary result opens the possibility of installing a transmitter on a buoy anchored at this point to receive additional data, such as air or seawater temperature, sea level, wave height, and other parameters.


Fig. 4. Elevation profile and distance achieved in LoRa mode.

## D. Comparison with the previous system

The previous system, based on an Atmel 89S4051 microcontroller, was difficult to maintain because we no longer use this circuit or its development environment in our teaching activities. The change to Arduino has greatly simplified this task, providing sufficient reason for the upgrade.

The new Atmega 328P-PU microcontroller (from the same manufacturer), in addition to being compatible with Arduino, has a RISC architecture, meaning its instruction execution speed is 12 times faster in most cases. This allows the clock frequency to be reduced to 1MHz or lower without loss of efficiency and improves power consumption. Furthermore, the memory size and the set of integrated peripherals are superior, such as the analog-to-digital converter used for some of the sensors.

On the other hand, the RFM95W transceiver clearly improves the previous RTFQ1 module not only in its versatility (FSK or LoRa modes, output power, and programmable data rate), but also in its improved range and even lower power consumption. We performed several measurements in real use of the weather station, which transmits one data frame per minute:

1) Previous module RTFQ1. The transmission time for a frame from the weather station is 800 ms, with a speed of 4.8 Kb/s, a current of 10 mA, and a power of 5 dBm (4 mW). Daily power consumption is 3.2 mAh. The typical range of this module is 50 m or less for stable reception.

2) RFM95W module in FSK mode. The transmission time in this case is 98 ms for a speed of 9.6 Kb/s, a current of 130 mA, and a power of 20 dBm (100 mW). In this case, daily power consumption is 3.92 mAh. With this module, we were able to receive data up to 1 km in open field.

3) RFM95W module in LoRa mode (SF=8, BW=62.5 kHz). This results in a transmission time of 576 ms and a daily consumption of 29.95 mAh. In this case, the reception distance exceeds 4 km in open field.

The most evident result of these tests is the significant increase in distance achieved with the same consumption. With the new radio module, the transmission time (and therefore the daily consumption) could also be reduced while maintaining the same distance achieved. When switching to LoRa mode, the transmission time increases significantly, but so does the distance achieved, and to the same extent, the reliability of the link at shorter distances, which is why this method was chosen. The previous module does not allow for any of these improvements, nor can the speed be increased to 9.6 Kb/s because the communication is no longer reliable.

The power supply system has been improved by increasing the power of the solar panels (2 cells of 6 V, 150 mA, 900 mW in the new system compared to 2 cells of 4.4 V, 88 mA, 310 mW in the previous one). Combined with a new 3.6 V, 3300 mAh battery, it achieves several months of autonomy under conditions of minimal solar radiation.

Regarding maintenance, the new system is easier to maintain and update due to the use of the Arduino environment and the change to current circuits and sensors widely available on the market. The design has also been simplified by the use of peripherals already integrated into the microcontroller.

## E. Approximate budget

The approximate cost of materials for building a transmitter node has been calculated and is presented in Table 1. The receiver board shares many of the components, except for the sensors, batteries, and solar cells, which are replaced by a USB power supply and an Ethernet or Wi-Fi module, so the cost is similar. Prices are in euros and correspond to the most economical suppliers. The approximate total is less than 50 euros for a complete transmitter or receiver.

TABLE I. BUDGET PER NODE

| **Nodo Transmisor** | | | |
|---|---|---|---|
| ***Component*** | ***Quantity*** | ***Price*** | ***Total*** |
| Micro ATMEGA328P-PU | 1 | 3 | 3 |
| Module LoRa RFM95W | 1 | 5 | 5 |
| Sensor T-H SHT35 | 1 | 6 | 6 |
| Sensor P BMP180 | 1 | 0,6 | 0,6 |
| Regulator LP2951 | 3 | 0,5 | 1,5 |
| Set R,C SMD | 1 | 5 | 5 |
| Diodes | 1 | 2 | 2 |
| Connectors and cables | 1 | 10 | 10 |
| PCB | 1 | 2 | 2 |
| Solar Panel 6V-150mA 80mm | 2 | 1,5 | 3 |
| Ni-MH batteries | 3 | 1 | 3 |
| Waterproof box | 2 | 2 | 4 |
| TOTAL (EUR) | | | 45,1 |

The cost could apparently be lower using commercial modules, for example, by combining an Arduino UNO with a RFM95W board and a solar battery charger. This solution could be suitable for testing or in schools without an electronics workshop, as the programs could be reused. However, reliability would be limited due to oxidation problems, connection failures, or poor adaptation of the radio frequency components. Furthermore, for vocational training students, the educational value of designing, assembling, soldering, and verifying the constructed modules must be considered.

The budget does not include other elements such as a rain gauge, anemometer, wind vane, or pyranometer. These items can be quite expensive, exceeding 200 euros for good quality models. Therefore, it is necessary to include the design and 3D printing of these elements as part of the future tasks of the project, as discussed in the following sections.

## IV. Planned educational activities

Throughout previous years, vocational training students had already participated in the design and assembly of the digital radiocommunications module and in the testing phase, as well as in the CanSat 2023 Challenge organized by the European Space Agency [7]. In the current and subsequent years, it is planned the development of applications based on the module, such as the weather station presented in this article or the oceanographic buoy.

The activities of the current 2025-26 academic year have been carried out within the framework of the Meteoescolas Program, convened by the Education Authority of Galicia in collaboration with Meteogalicia [8], the Meteorological Agency of Galicia. Although the Meteoescolas Program is primarily aimed at disseminating meteorology and climatology in primary and secondary schools, in recent years it has been opened to the participation of other educational levels, such as vocational training. We have taken advantage of this opportunity to include tasks with a strong technological focus, which can be extended to other centers that wish to participate in the future, as all the materials developed are free to use, both hardware and software.

In the current course, students from the Vocational Training Degree in Electronic Maintenance are participating. Future collaboration is planned for other vocational training students at the center and even from other educational stages such as Secondary Education (ESO) or Science and Technology Baccalaureate.

Ten activities have been initially planned, distributed across three categories: basic training in acquisition and transmission systems, design and construction of station components, and data dissemination activities. These are briefly described below:

1) Construction of sensor modules. This training activity is designed to familiarize students with sensor data acquisition and radio transmission. Our own radiocommunications module is used, connected to different types of environmental sensors (temperature, humidity, atmospheric pressure, solar radiation).

2) Installation and connection of a LoRaWAN router. As a complement to the previous activity, this exercise involves connecting commercial modules to a router installed at the center.

3) Design and construction of meteorological sensors. Using the 3D printers available at the center, the necessary parts for assembling low-cost anemometers, wind vanes, and rain gauges are designed, incorporating electronic sensors such as reed relays, Hall effect sensors, or continuous rotation potentiometers, along with the required mechanical components.

4) Construction of a weather station outdoor box. The project involves constructing a shelter using 3D printing or prefabricated wooden or plastic parts to house and protect the station's sensors. This activity, along with the previous one, may involve students from subjects such as Technology or other innovation initiatives like the 'Polos Creativos' (Creative Workshops) that are being carried out in numerous schools in Galicia.

5) Assembly of a complete station with electronic modules and sensors, programming the transmission and reception, and sending the data to a web server.

6) Data processing on the server. This activity will consist of programming scripts in languages such as PHP or Python for receiving, storing, and disseminating the acquired data. Data will also be forwarded to external networks (such as Meteogalicia) using the protocol required by each network.

7) Model of an oceanographic buoy. Based on the activities related to the sensor modules, an autonomous, solar powered device will be developed, constructed with watertight materials capable of withstanding the marine environment, for acquiring new data such as seawater and air temperature, tide height, and wave height.

8) Data Analysis. Using current and historical data, different types of analysis will be performed with the application of appropriate algorithms for error detection, maximum and minimum measurements, trends, and variability, with automatic report generation and dissemination of results.

9) Development of web interfaces for data visualization. Design of interactive web panels for the real-time representation of meteorological variables using graphs, tables, and alert systems. This activity will allow students to work on aspects related to web programming, databases, and the visualization of scientific information.

10) Application of artificial intelligence techniques. Development of tools based on artificial intelligence and machine learning algorithms for the analysis of acquired meteorological data. This activity will include the automatic detection of sensor anomalies, the identification of climate patterns and trends, as well as the creation of basic weather forecasts from time series. Furthermore, it will allow students to be introduced to concepts related to data science, big data processing, and the use of AI tools applied to IoT systems.

Due to its wide scope, this set of activities has been designed to ensure the project's continuity in subsequent years.

## V. Learning results and evidence

The tasks for this course were developed within the Microprogrammable Equipment, Radiocommunications Maintenance, and Voice and Data Equipment Maintenance modules of the Vocational Training Degree in Electronic Maintenance. One of the characteristics of our center, located in the rural area of a large city like Vigo, is a small number of students in the higher levels, with a total of 19 in the first year and 6 in the second year of the Vocational Training Degree in Electronics. These small groups facilitate a high level of task diversification and adaptation to the students' individual characteristics.

In the first-year Microprogrammable Equipment subject, students used their own microcontroller boards to develop personal projects, including examples such as an electronic lock, motor regulation, a temperature and pH controller for a swimming pool, and even a simple video game with an LCD screen. This subject develops skills related to electronic hardware design and programming, so these tasks serve as preparation for tackling more complex projects in the next academic year.

In the second-year Radiocommunications subject, which develops skills related to the assembly and maintenance of transmission systems, students used specialized boards for indoor and outdoor transmission and reception practice, taking advantage of the center's distribution in two buildings separated by a garden area with sports fields. These types of activities help students understand the basic operating principles of radio communications by electromagnetic waves.

In the Voice and Data Equipment Maintenance subject, students prepared LAMP servers on Linux machines running Ubuntu, installing the necessary software packages to create an Apache, MySQL, and PHP server. A dynamic website was built on this server, capable of displaying data stored in a MySQL database. For the graphical presentation, they took advantage of their experience with libraries such as Apache Echarts, which allows for creating graphs directly from the database. These tasks serve as preparation for the new weather station data storage scheme in MySQL databases using queries programmed in PHP.

In the Meteoescolas project, several tasks have been partially completed, such as sensor testing and construction of the electronic part of the complete station (provisionally using a commercial anemometer, wind vane and rain gauge), and data processing in PHP language by updating the existing version.

These activities were carried out by the students of the Vocational Training Degree, with the collaboration of the teachers for the more complex tasks.

The connection to external networks has also been completed by adding a script for sending data to Meteogalicia. The previous version of the station had already been connected to the Meteoclimatic and Awekas networks, but integration with Meteogalicia represents a significant improvement, as it is an official meteorological network. This would not have been possible without participation in the Meteoescolas Program. This process also demonstrates the usefulness of developing custom software, because commercial systems like Davis and others often cause incompatibilities or limit the number of possible connections. In our case, a software module can be added for each network to which we wish to connect, adapting to any requirement of type of connection, format, or timing. Fig. 5 shows the station's data screen as displayed on the Meteogalicia website [9].

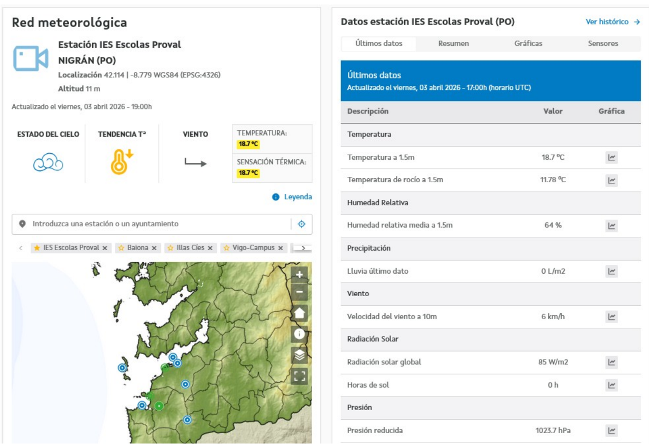



Fig. 5. Station data screen on the Meteogalicia website.

## VI. Future Proposals

For the next courses it is planned to complete the design of the station's electronic module, adding new microcontroller models such as the ESP32, with greater memory capacity and Wi-Fi connectivity.

The current version of the receiver uses a Wiznet 5500 Ethernet module with an RJ45 connector. This configuration had the disadvantage of requiring proximity to a wired network connection, which is not always available in an educational center. In the Cansat Challenge [7], a more flexible configuration was successfully tested using an ESP32 module with a Wi-Fi connection to an access point that acted as a gateway between the receiver and the data server. This portable solution allowed students to point the receiving antenna at the descending probe without worrying about cable length. In the case of the weather station, it is possible to place the receiver module in the most appropriate location to receive the data, even outdoors, and retransmit it to the educational center's wireless network. The tests we have carried out with commercial modules such as the Heltec ESP32-LoRa [10] demonstrate the viability of this solution.

ESP32 microcontrollers are sold in different formats and pinouts, so we plan to design a board with different sockets and connections to allow the use of any of the modules on the market, thus avoiding stock shortages or price increases that frequently affect some electronic components in recent years.

Another proposal is the construction of an oceanographic buoy prototype that will allow us to acquire new data such as sea temperature, tide height, and wave height. For this purpose, we are already beginning tests of a power supply with multiple solar cells and developing watertight prototypes with PVC pipe for testing in a water container or pool.

We also plan to update the data storage on the server with the MySQL database system described and improve the visualization of results. During the transition to the new storage system, both configurations (current daily text files and database) will be maintained. Once the new system is validated, the data from the previous system will be migrated to the new format, keeping the text files as a backup.

Finally, automated analyses will be performed using the data series stored for the 20 years between 2005 and 2025.

## VII. Conclusions

This article describes the process of upgrading the weather station at the Escolas Proval High School in Nigrán (Pontevedra), a project initiated 20 years ago that continues a century-old tradition of meteorological observation.

The project is based on a previously developed radio communications module used to send data from sensors placed in an outdoor box directly to a web server. The LoRa technology of the transceiver used increases the transmission distance, improves the system reliability, and allows the receiver to be placed almost anywhere on the school. The station's previous microcontroller has been replaced with a model compatible with the Arduino environment, and the sensors have been upgraded.

The new weather station was developed within the framework of the Meteoescolas Program, sponsored by the education authorities, which has facilitated the development of educational projects in different subjects of the Vocational Training Degree "Electronic Maintenance." This program has also enabled the integration of the station into the official network managed by Meteogalicia, the Meteorological Agency of Galicia.

Future improvements include the use of new microcontrollers such as the ESP32, the development of an oceanographic buoy based on the system, the change of the storage system to MySQL databases, and the automated analysis of the historical data set.

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