

## **DIVULGE THE GEOGRAPHY FROM A COLLABORATIVE WORK IN THE WEEK OF SCIENCE, TECHNOLOGY AND INNOVATION. THE STAND “FROM THE DATA TO CLIMATIC GRAPH”**

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### **1. INTRODUCTION**

Despite some authors point out (Fernández, Mecha and Milan, 2018, p.7) “*the dissemination has not traditionally contributed anything positive to the curriculum, nor has it been recognized by colleagues*”, teachers and researchers must also be actives in the dissemination of knowledge. The university we belong to, the University of the Basque Country / Euskal Herriko Unibertsitatea, has the motto “Eman ta Zabalzazu / Give and spread”. According to Article 4.1 of its Statutes (University of the Basque Country / Euskal Herriko Unibertsitatea, 2011, p. 10-11), among others, its purposes are: “*the creation, criticism and transmission of knowledge, contributing to the advancement of knowledge and to social development through research and transfer of its results to society; the participation in the enrichment of the intellectual, humanistic, cultural and scientific heritage of the Basque society and in its economic development and social well-being and the diffusion and university projection*”. This university has assumed this commitment for fifteen years (Orruño, Bikandi, San Millán and Arana, 2015, p.36). Initially, through its Vice-Rectorate for Research and nowadays, through the Vice-Rectorate for Scientific Development and Transfer, it has undertaken the responsibility of the annual organization of activities associated

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with the Week of Science, Technology and Innovation (SCTI) in the three Historical Territories of Euskadi.

Within this framework, in collaboration with members of the Meteorological Sensors Calibration Laboratory of the School of Engineering of Vitoria-Gasteiz, we design and develop a new stand activity that has been carried out annually since 2014 until 2018. The activity has the motto “*From the data to the climatic graph*” and its objectives are the following:

- provide access to scientific information, in this case related to climatic variables, to a large and diverse audience;
- interact in a pleasant way, through an informal activity, in order to generate interest in technological and geographic practice knowledge and research;
- show the citizens the necessity and scientific work collaboration value.

## **2. METHOD AND MATERIALS**

To achieve these objectives, a set of activities has been designed based on the diversity of the audience that will visit the stand. The SCTI is held in Vitoria-Gasteiz from Thursday to Sunday (November) and, while students of the Compulsory Secondary Education and Bachillerato attend to the stand during the first two days, the weekend is open to the public.

The activities designed and developed consist of:

- A) “*Where, what and how is it measured*”. Exhibition of measuring instruments of a weather station and introduction of the parametric variables and measurement techniques by the collaborators.
- B) “*How and for what is this data used in Geography*”. Atmospheric data sample treatment used in geography: climatic process analysis and characterization.
- The collaborators carry out the activities with various presentations and development strategies (Tables 1 and 2) adapting the level to the audience. After finishing the presentation of Activity A and to link it with Activity B according to the second objective, it is always indicated: “*Well, with all these data, once verified, in Geography they are used for...*”.

The method of transmitting information in this section is deductive for both young and adult public: from the most general, distinguishing between weather and climate, meteorology and climatology, atmospheric dynamics, etc..., to the most precise facts

collected in data, graphics and mapping (Ramos and Calonge, 2014). The resource to the scale of the nearby territory (annual average data and graphics of the Autonomous Community of the Basque Country and daily data of the city of Vitoria-Gasteiz) is also included.

These activities are carried out using various material resources. In response to the first objective mentioned in Activity A, “Where, what and how it is measured”, instruments provided by the Basque Meteorology Agency EUSKALMET are used. These fully working sensors are accompanied by a laptop with the required software to visualize, in real time, all the variables required in the presentation of the activity (Figure 2).

In order to achieve the first objective, along with the second and third objectives of the project, it has been showed in Activity B “*How and what are those data used in Geography*” the monthly data of the weather observatories of the airports of Vitoria-Gasteiz (since 1945) and Bilbao and Donostia-San Sebastián/Igeldo (since 1981). All of them supplied by the Territorial Delegation in the Basque Country of the AEMET State Meteorological Agency. The monthly records since 2001 of the various meteorological stations belonging to the Basque Meteorological Agency EUSKALMET have also been used. This information has been compiled (<http://opendata.euskadi.eus/>) and treated in an Excel document for the realization of Activity B and the elaboration of different climatic graphs (on an equal scale) that have been printed and laminated for use in the climogram location game -second objective- (Figure 3).

In addition, for both scales of the game, worldwide and regional, a relief wall map of the Basque Country and a satellite image of the earth’s surface has been used. In the Activity B, a computer has also been used in order to:

- show the daily data of various meteorological stations available on the website of the Basque Meteorological Agency EUSKALMET (<http://www.euskalmet.euskadi.eus/>) and the corresponding map, model and graphic figures (Figure 4 );
- present a PowerPoint document that succinctly and graphically summarizes the factors that determine global climatic diversity (Figure 5) which helps to interpret and respond appropriately in the location game;
- submit an Excel document containing monthly data from the climatic series of Vitoria-Gasteiz;
- show graphical information on extreme records (Moncho, Bella and Caselles, 2011, p. 122) (Figure 6) and on models graphs that explain the factors that determine a type of weather with significant records of some of the atmospheric variables (Figure 7);
- inform the public of different websites on meteorological, marine and prediction data.

Finally, in each editions a poster has been prepared on different climatic variables and elements. They contextualize their range of variability and the different measurement methods used in meteorological science, both manual and automatic.

On the other hand, the human resources that the stand has had for the realization of the activities have been professors of the area of knowledge of Physical Geography of the Department of Geography and the Department of Electronic Technology, as well as technicians of the Laboratory of Calibration of the Vitoria-Gasteiz School of Engineering. In addition, students of 4th year of the Geography and Territorial Planning Degree and postgraduate have collaborated in the stand every year.

### **3. RESULTS**

The experience of organizing a stand at the Week of Science, Technology and Innovation at the UPV / EHU in response to the objectives mentioned has resulted in bringing to citizenship to scientific information of technological nature as causal and descriptive. It has showed in a single stand how research in a science field, in our case the geographical one, requires databases collected and contributed both by other technological and knowledge areas and by diverse entities. These facts can be expressed from an interaction activity with those who visit the stand.

#### **3.1. Divulge about technology and geographic science through a collaborative project**

Regarding Activity A “*Where, what and how it is measured*”, the physical presence of a weather station and its presentation and explanation have made it possible to understand the operation and magnitude of the infrastructure required to obtain reliable data. The availability of out-of-use sensors has served to closely visualize the nature of the transducers, thus facilitating the understanding of the technical explanation. International research and programs that are available on the internet have been used to disseminate other parameters that are obtained at the planetary level and that help to better model the state of the atmosphere. The following aspects related to the meteorological metrology have been treated during the visits depending on the age, prior knowledge, interests, etc.:

- importance of calibration to obtain consistent time data series;
- accreditation of laboratories that calibrate meteorological sensors;
- data uncertainty: the importance of knowing the uncertainty of each measure and its influence on the models, or when using such data;
- value of metadata, those unknown partners of the measure that provide quality to it and that are usually ignored;

- advantages of automatic weather stations at managing risks due to heavy rainfalls.

In Activity B “*How and what are these data used for in Geography*” (and always depending on the audience at the stand), different themes of the geographic disciplines related to climatology have been addressed:

- verified sensor data and the total and daily, monthly and annual averages calculation of variables that allow showing the distinction between the concepts of Weather and Climate and between Meteorology and Climatology;
- analysis of the main factors and processes involved in the spatial, seasonal and annual climatic variability: variables and atmospheric dynamics in different latitudes conditioned by seas, reliefs, continents and the phenomena of the Southern Oscillation-El Niño (ENSO) and the North Atlantic Oscillation (NAO);
- interpretation of global climatic diversity according to two descriptors: the temperature and precipitation annual average records and their monthly regimes compared to Vitoria-Gasteiz data: some of the rainiest and driest places in the world, the determining factors and the characteristics of the seasonal distribution of temperature and precipitation values, as well as the thermal and rainfall annual average values;
- analysis of climatic variability in the Autonomous Community of the Basque Country and the main factors involved in it. The data of almost 20 years of registration of the stations of EUSKALMET and of more than 30 years of AEMET have allowed to elaborate a wide number of climograms that show the diversity of records and distribution of precipitation, annual average values of temperature and thermal amplitude, dry months, differences in the behaviour of the monthly average values of the minimum and maximum daily temperatures depending on the proximity to the sea, the altitude or the continentalization;
- Importance of using long series of data for the optimal characterization of weather patterns: this activity has been carried out using the climatic graph of the Moreda weather station that, with only 6 years of registration, does not adequately represent the pattern that corresponds to this area (Figure 10).
- rigor in the use and transfer of information of general interest: the relationship between personal perception and registered data. Confirmation, with verified data since records for the city of Vitoria-Gasteiz exist, of how the weather is usually perceived: “*it snows less than before*” (chronological comparison with the calculation of monthly and annual snow days). “*It rains less than before*” (chronological comparison with the amount of precipitation recorded monthly and its trend line). “*Temperatures are higher than before*” (chronological comparison in average monthly temperature, monthly average of maximum daily temperature,

monthly average of the minimum daily temperature, monthly absolute maximum temperature, monthly absolute minimum temperature and its trend lines) and “*there are less frosts than before*” (number of days of monthly frost).

### **3.2. Interact with citizens in an enjoyable way in order to interest them in technological and geographical practice**

The preparation of the materials to compose the information that could be used in the stand has consisted of an arduous work conditioned by the diversity of those who can approach the stand to be interested in its content. Therefore, depending on the type of audience, this material has been adapted and the narration and the characteristics of the activity modified.

In Activity A “*Where, what and how to measure*”, it has been shown the “*housing and entrails*” of each sensor, namely, “*irrigate*” water in the rain gauge to perceive how the cups tip over. Press a “*filament*” with your fingers to check graphically on the computer how the temperature rises. Blow in front of the anemometer to determine the speed of the “*wind*”. Get an idea of the volume of the rain that falls in a year in Vitoria-Gasteiz and compare it with the one that falls in other places of the world. Guess the name of what it looks like a “*flying saucer*” but it is a radiometer...All these experiences have meant an approach to instruments and technology for the general public that has shown its gratitude for seeing and understanding a weather station. However, it has also been a knowledge experience for those more specialized who have been explained the difference between “*calibrate*” and “*adjust*” or that °C means Celsius degree and not centigrade degree. How the calibration of different sensors is carried out; or what is the physical principle used to determine the temperature in the automatic sensors used by EUSKALMET, which is nothing than, the measurement of the variation of a platinum resistance. This variation, in turn, is amplified and becomes a variation of voltage, so that a variation between 40 °C and 60 °C becomes a continuous voltage variation between 0 V and 1 V. Topics such as the problem of automatic measurement that are compensated with the immensity of the data collected and statistics, etc. have also been addressed.

In Activity B “*How and what are these data used for in Geography*”, the ten-minute data of the moment with the surface and height models and radiosoundings have been compared. Observe the average and absolute monthly data of long series to, in some cases, determine ephemeris and analyse their causes by consulting the models corresponding to that day and, in other cases, know the pattern of each of the atmospheric parameters and observing its temporal variability. Learn about aspects such as the effects on the atmospheric dynamics of the warm and cold currents of the seas or the intensity and direction of the pressure gradients and their oscillations. Observe the spatial and

temporal distribution of various atmospheric variables on synthetic maps. Interpret climatic graphs and know how to locate them on the global and regional scale or simply matching the coloured spots and shapes of the image on the computer screen with the image on the display table in the case of younger children has been a practical approach to the geographical work done in an interactive and enjoyable way. Remember personal experience in the memory of ephemeris, observe numerical comparisons contrasted graphically and validate information or particular knowledge through identification and location games has been a didactic work carried out by the collaborators in the stand that has had one smile as reward and the expression of gratitude by those who have participated in the activity.

Finally, in order to fulfil the third objective, to show citizens the need and value of collaboration in scientific work, two different university centres have worked together in a single stand and people from different areas of knowledge collaborating have made visible the fact of complementarity as a strength of educational and scientific work (Figure 11).

#### **4. CONCLUSIONS AND DISCUSSION**

Through the activities presented here, the “*From the data to the climatic graph*” stand, on the Science, Technology and Innovation Week is a non-formal learning opportunity for students in different educational levels. This activity is linked with essential contents within the Geography curriculum (Tonda and Sebastiá, 2003) and similar to other proposals in museums (Morote and Moltó, 2017) or workshops in the classroom (Cruz, 2010). In this sense, it should be noted that usually the teaching staff of the registered educational centres that accompanies the school groups in the SCTI belong to science studies and therefore it is the students of this branch of knowledge who visit the stands. Therefore, the need that teachers from other areas of knowledge also echo this event and attend it with the students of their subject is stressed. In our case, the activities of the stand can be an innovative educational resource for teachers of the subjects of Social Sciences of Primary Education, Geography and History of CSE and Geography of Spain in Bachillerato (Martínez and Olcina, 2019). But it is also an occasion to transfer knowledge to society as a whole. Hence, the importance of the capacity of those responsible for the stand to adapt the discourse and materials developed for the presentations to a diverse audience.

In the time that the divulgation experience has lasted, the presentations have been modified and adapted in response to the motivation shown by the participants in the stand and the suggestions received from them. In addition, new visual sources of meteorological and climatic information as have been incorporated. Certainly, the experience has not

had a satisfaction diagnosis from public as no questionnaire has been elaborated and therefore it what is collected in this article only expresses the qualitative assessment of the authors. We consider that the characteristics of the event organized and coordinated by the Vice-Rectorate for Scientific Development and Transfer, massive and open to all types of public, with numerous stands, workshops and other activities, do not favour the completion of satisfaction questionnaires. On the other hand, it would be pertinent for subsequent editions to carry out a survey aimed at students of Secondary Education and Bachillerato once their visit to the SCIT is completed. This would allowed knowing the suitability of the proposed activities related to the skills acquired in the educational curriculum.

Moreover, it is an opportunity for the transmission and projection of Geography. A science that, although it deals with topics of current and general interest, as a school discipline has suffered in recent years a significant reduction in its presence in the curriculum (Olcina, Zúñiga and De Miguel, 2018). In this situation, as teaching geographers and researchers we are also carrying out a visibility work through the stand that we consider essential.

Finally, we want to insist on the value of collaboration between areas of knowledge. Geography needs the territorial analysis, the quantitative data contributed, among others, by the parametric technologies and from diverse sources. From our perspective, showing society this collaborative action through the stand is a pedagogical milestone.